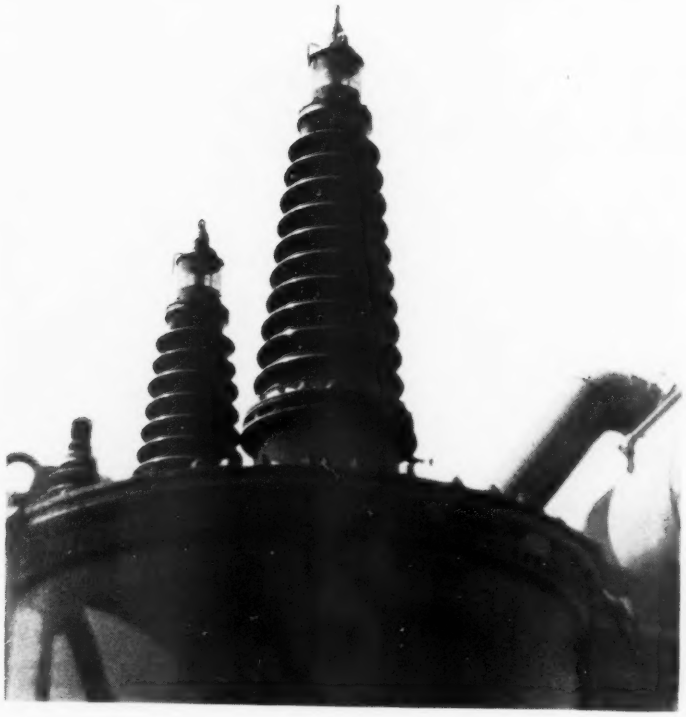
EDISON ELECTRIC INSTITUTE BULLETIN



VOLUME II MAY 1934 NUMBER 5

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

Compiled Monthly by the Edison Electric Institute—Covers 100% of the Industry

DURING THE MONTH OF MARCH

	1934	1933	%
Kilowatt-hours Generated* (net)			
By Fuel	4,313,961,000	3,368,206,000	+28.1
By Water Power	2,815,169,000	2,797,897,000	+ 0.6
Total kilowatt-hours generated	7,129,130,000	6,166,103,000	+15.6
Additions to Supply			
Energy purchased from other sources	173,646,000	146,878,000	+18.2
Net International Imports	80,541,000	29,881,000	+169.5
Total	254,187,000	176,759,000	+43.8
Deductions from Supply			
Energy used in electric railways departments	64,844,000	61,462,000	+ 5.5
Energy used in electric and other departments	120,241,000	99,119,000	+21.3
Total	185,085,000	160,581,000	+15.3
Total Energy for Distribution	**7,198,232,000**	**6,182,281,000**	**+16.4**
Energy Lost in Transmission, Distribution, etc.	1,402,329,000	1,304,597,000	+ 7.5
Kilowatt-hours Sold to Ultimate Consumers	**5,795,903,000**	**4,877,684,000**	**+18.8**
Sales to Ultimate Consumers (kw-hrs)			
Domestic Service	1,055,511,000	1,003,801,000	+ 5.2
Commercial—Small Light and Power (Retail)	1,046,303,000	984,337,000	+ 6.3
Commercial—Large Light and Power (Wholesale)	2,970,849,000	2,221,155,000	+33.8
Municipal Street Lighting	191,391,000	196,157,000	- 2.4
Railroads—Street and Interurban	412,863,000	361,043,000	+14.4
Railroads—Electrified Steam	66,041,000	54,527,000	+21.1
Municipal and Miscellaneous	52,945,000	56,664,000	- 6.6
Total Sales to Ultimate Consumers	5,795,903,000	4,877,684,000	+18.8
Total Revenue from Ultimate Consumers	$149,780,400	$142,487,100	+ 5.1

DURING TWELVE MONTHS ENDING MARCH 31st

Kilowatt-hours Generated* (net)			
By Fuel	50,069,063,000	44,399,196,000	+12.8
By Water Power	31,148,736,000	30,612,016,000	+ 1.8
Total Kilowatt-hours Generated	81,217,799,000	75,011,212,000	+ 8.3
Purchased Energy (net)	3,168,464,000	2,664,070,000	+18.9
Energy Used in Electric Railway and Other Departments	1,937,457,000	2,012,240,000	- 3.7
Total Energy for Distribution	**82,448,806,000**	**75,663,042,000**	**+ 9.0**
Energy Lost in Transmission, Distribution, etc.	14,499,037,000	13,610,448,000	+ 6.5
Kilowatt-hours Sold to Ultimate Consumers	**67,949,769,000**	**62,052,594,000**	**+ 9.5**
Total Revenue from Ultimate Consumers	$1,787,563,300	$1,788,793,400	- 0.1
Important Factors			
Percent of energy generated by waterpower	38.4%	40.8%	
Average Pounds of Coal per Kilowatt-hour	1.45#	1.49#	
Domestic Service (Residential Use)			
Average Annual Consumption per Customer (kw-hr)	608	596	+ 2.0
Average Revenue per Kw-hr (Cents)	5.44¢	5.58¢	- 2.5
Average Monthly Bill per Domestic Customer	$2.76	$2.77	- 0.4

BASIC INFORMATION AS OF MARCH 31st

Generating Capacity (kw)—Steam	23,983,200	24,044,500	
—Water Power	9,004,800	8,967,500	
—Internal Combustion	470,700	457,900	
Total Generating Capacity in Kilowatts	33,458,700	33,469,900	
Number of Customers			
Farms in Eastern Area (Included with Domestic)	(506,861)	(502,778)	
Farms in Western Area (Included with Com'l—Large)	(205,805)	(203,337)	
Domestic Service	20,097,087	19,730,932	
Commercial—Small Light and Power	3,681,696	3,657,532	
Commercial—Large Light and Power	520,782	521,427	
All Other Ultimate Consumers	67,865	72,194	
Total Ultimate Consumers	24,367,430	23,982,085	

*By courtesy of the U. S. Geological Survey with deductions for certain plants not considered Electric Light and Power Enterprises.

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume II MAY, 1934 No. 5

INFORMATION ON THE SECOND ANNUAL CONVENTION

To Be Held at Atlantic City, June 4th-7th

The program for the Second Annual Convention of the Edison Electric Institute, to be held at the Hotel Traymore, Atlantic City, June 4 to 7 inclusive, has been completed. It is summarized on this and the following page.

The Convention this year will be more in the nature of an industry conference than is usual with an annual meeting of a large industry association. This type of convention will permit greater opportunity for individual expression during business sessions and, because of the limited number of sessions, will also give more time for informal meetings and discussions by delegates.

The subjects that have been selected for discussion at the general sessions all have a vital bearing on present day operation of the electric light and power industry. They include the allocation of costs of service in the electric industry, sales subjects of pressing importance, trade relations, practical engineering changes which reduce costs, the status of the holding company, the adjustment of operations to present trends, and commodity prices.

Four general sessions, all of which will be open to anyone interested in the electric light and power industry, will be held during convention week, and in addition a number of committees of the Institute have called meetings during the convention period. These committee meetings are listed on the next page. The general sessions will be held during the mornings of Tuesday, June 5; Wednesday, June 6; Thursday, June 7, and on the evening of Wednesday, June 6.

Monday, June 4, two executive sessions will be held with attendance restricted to member company representatives. Admittance to these two sessions, the first at 10 a. m. and the second at 2.30 p. m. will be by cards, to be distributed at the registration desk. Subjects such as the status of the NRA code for the electric light and power industry, innovations in rate structures, and other matters of interest to the industry will be discussed.

Convention headquarters will be at the Traymore Hotel, where all meetings will be held, and where the registration and information desks, executive office and railway ticket validating offices will be located. A spacious hall will be provided by the hotel for the general sessions, and arrangements have been made for smaller conference rooms to accommodate the meetings of the several committees.

Thoughtful attention is being given to the details of management of the convention, and every effort will be made to provide for the comfort and convenience of delegates. The registration and information desks will be at the service of delegates, and members of the general office staff of the Institute will also be glad to extend all courtesies possible. Likewise, hotel men and public officials of Atlantic City will be anxious to make the stay of visitors a pleasant one.

The attractions of the famous ocean resort, in all probability, are well known to most of those who will attend the convention, and the rotogravure sections of newspapers, motion pictures, radio, magazines and the Atlantic City Publicity Bureau have made others quite familiar with what Atlantic City has to offer in the way of recreation. The location of convention headquarters is ideal for combining business with vacation relaxation. Most of the attractions of the city are grouped along, or within a short distance of the Boardwalk, and attendance at the sessions of the convention may, for those so inclined, be combined with enjoyment of the many attractions of the resort. The adjournment of the convention on Thursday will leave free a long week-end that will probably be utilized by

many for relaxation on the sands of the beach, or at the excellent golf clubs in the vicinity.

To give the ladies attending the convention an opportunity to meet old friends and make new ones a tea will be given in the Rose Room of the Hotel Traymore, from 4 p. m. to 6 p. m., June 4. On Monday evening, there will be dancing for convention guests. The dance will be held in the American Dining Room, adjoining the main lobby of the Traymore Hotel.

First General Session

The first session will convene at 10 o'clock, Tuesday morning, June 5. President George B. Cortelyou will deliver the opening address. A portion of his address will be concerned with the Institute's progress since its organization last year, and will include a report on its major activities and accomplishments that should be of great interest to members. Mr. Edward Reynolds, Jr., treasurer of the Institute, and Mr. Bernard F. Weadock, vice-president and managing director, will discuss the Institute affairs which come within their special jurisdiction.

At this same session an important "Plan for Determining Costs of Service in the Electrical Industry" will be presented by Mr. Hudson W. Reed, management engineer, The United Gas Improvement Company, Philadelphia. Discussion of the plan will be made by Mr. Arthur H. Kehoe, vice-president, The New York Edison Company; Mr. Mark Eldredge, chief engineer, Memphis Power and Light Company, and Mr. Norman R. Gibson, vice-president, Niagara Hudson Power Corporation, Buffalo.

Second General Session

The second general session, beginning at 10 a. m. Wednesday morning, June 6, will be devoted to sales and merchandising problems. The first address on the program will be given by Mr. George E. Whitwell, chairman of the Sales Committee of the Institute and vice-president of the Philadelphia Electric Company. Mr. Whitwell will have as his subject "The Business of Getting Business." Mr. Allen L. Billingsley, president, Fuller & Smith & Ross, Inc., Cleveland, will discuss the "Economics of an Electrical Home." Mr. T. K. Quinn, vice-president, General Electric Company, New York, has accepted an invitation to present the facts and offer practical solutions on "Facing Competition."

Mr. James E. Davidson, president of the Nebraska Power Company, will discuss "Dealer Co-ordination as an Aid in Load Building." The concluding event of this session will be a novel and instructive demonstration of "Light and Vision—The New Partnership," a presentation of the Better Light—Better Sight Committee, Mr. M. E. Skinner, Niagara Hudson Power Corporation, Buffalo, Chairman.

COMMITTEE MEETINGS DURING CONVENTION

All meetings to be held in Hotel Traymore. Committee members to be informed of meeting rooms.

Monday, June 4th

1:15 p.m. Statistical Committee, Luncheon Meeting
5:00 p.m. Accounting Committee

Tuesday, June 5th

1:15 p.m. Operating Committee, Luncheon Meeting
3:00 p.m. Power Generation Committee

Wednesday, June 6th

1:15 p.m. Sales Committee, Luncheon Meeting
3:00 p.m. Electrical Equipment Committee
3:00 p.m. Transmission and Distribution Committee

Third General Session

The third general session will be held at 8.40 p. m. the evening of Wednesday, June 6. Addresses at this session will be made by Mr. Floyd L. Carlisle, member of the Board of Trustees of the Institute and chairman of the Boards of the Niagara Hudson Corporation and the Consolidated Gas Company of New York, and Mr. Bernard F. Weadock of the Institute. Mr. Weadock's address will be a discussion of holding companies.

Fourth General Session

The fourth and concluding general session will begin at 10 a. m. Thursday, June 7, with a paper, "Progressive Engineering Pays Its Way," by Mr. Philip Sporn, vice-president, American Gas and Electric Company, New York. Discussion of Mr. Sporn's paper will follow its presentation. Mr. J. L. Hecht, Public Service Company of Northern Illinois, Chicago, will have as his subject "Adjusting Operations to Present Trends." Mr. F. A. Newton, The Commonwealth and Southern Corporation, New York, will present a discussion on "Commodity Prices" and their relation to costs of production of electricity. At this session, Mr. Frank W. Smith, president, The New York Edison Company, and chairman of the Prize Awards Committee, will announce the winners of the several prize awards administered by the Institute. Presentation of the awards will be made at the same time. The awards include the Charles A. Coffin Award; the H. M. Byllesby Prizes; the Forbes Prize; the A. L. Lindemann Prizes; the James H. McGraw Prizes; the Thomas W. Martin Award, and the George A. Hughes Award. On this occasion also, the first presentations of the new Edison Electric Institute Medal for resuscitation by the Prone Pressure Method will be made.

The report of the Nominating Committee, the election of trustees and the transaction of miscellaneous business of the convention will conclude the program.

Railway Identification Certificates and Hotel Information may be secured from the General Office of the Edison Electric Institute, 420 Lexington Ave., New York, N. Y.

General Information

Convention headquarters will be located at the Hotel Traymore, on the Boardwalk. Morning sessions will convene promptly at 10 a. m., daylight saving time, and adjourn at 1 p. m. The Wednesday evening session will convene at 8.40 p. m.

Registration and railroad ticket validating booths are on the main lobby floor of the Hotel Traymore adjacent to the meeting room. There will be no charge for registration, but registration is necessary to obtain the convention badge. Display of the badge is required for admission to the convention sessions. Registration booth will be open on Sunday, June 3, from 2.30 p. m. until 5 p. m. On Monday, June 4, the booth will be open from 8.30 a. m. until 1 p. m. and on Tuesday, Wednesday and Thursday from 9 a. m. until 1 p. m.

Recreation

On Monday, June 4, from 4 to 6 p. m. in the Rose Room, Hotel Traymore, a tea will be given for the ladies attending the convention. There will be dancing on Monday evening in the American Dining Room, main lobby of the hotel, at 9 p. m.

Hotels

A circular giving rates and locations of the principal Atlantic City hotels, together with a reservation blank has

(Continued on page 160)

STANDARDIZATION OF HOUSE METERS FOR INTERCHANGEABLE MOUNTING ACCOMPLISHED

In the BULLETIN of last February, emphasis was placed upon the important assignment undertaken by a working group of the Electrical Equipment Committee to bring about simplification, interchangeability, reduced cost and greater security against energy diversion in the mounting of customers' meters. The working out of a schedule of basic requirements coordinating as many as practicable of the large diversity of meter installation practices, was recognized as the key to the answer sought. Faced by this diversity of practices, meter manufacturers had found little encouragement to work for interchangeable standards.

The Meter Mounting and Energy Diversion Subcommittees, at a joint meeting in Cincinnati on March 30, 1934, agreed upon a schedule of basic requirements applicable to single phase watthour meters and a common mounting device. The Committee on Metering and Service Methods of the Association of Edison Illuminating Companies was consulted and its support obtained. These requirements are:

1. All manufacturers' meters shall be interchangeable and applicable to a mounting device which in turn should be suitable for use with all makes of meters.
2. The mounting device shall be designed for the character of installation in which it will be used for a single meter or a group of meters, either indoor or outdoor.
3. There shall be one seal for both meter and mounting device.
4. Service wires and service terminals shall be accessible after the meter is installed only by the removal of a seal.
5. Unmetered terminals for test purposes shall be under a seal.
6. Meters having a neutral potential connection shall be provided with a means within the meter of connecting the neutral to the meter base.
7. The meter base shall not be insulated from the mounting device. The mounting device shall be provided with an uninsulated terminal for the service neutral.
8. Service wires and load wires within the meter mounting should be kept separate and means provided to prevent the insertion of jumpers by unauthorized persons.
9. The meter equipment shall provide means for entrance of service as required by the character of installation.
10. If at all feasible the development should be of such a character that could be applied to existing meters.

The schedule of requirements accomplished, the representatives of the utility groups met with representatives of the four meter manufacturers, describing their objective, presenting their schedule of basic requirements and requesting cooperation, — this cooperation being immediately pledged.

The manufacturers responded promptly, proposing a solution at a joint meeting held in New York City, on May 2. This proposal was received favorably by the Electric Light and Power group and the manufacturers were advised to proceed at once with its execution. The manufacturers gave full assurance that the working out of all remaining details of design would be expedited and the new standard meters made commercially available very promptly. Orders will be accepted at once.

The Interchangeable Standardization Summarized

This new interchangeable standardization briefly may be defined as follows:

(1) Henceforth all four manufacturers will offer two standard single phase meters:

Type A—a bottom connected meter, similar to and interchangeable with the present Type A line manufactured by the General Electric, Sangamo, and Duncan companies.

Type S—a so-called socket or detachable meter, similar to and interchangeable with the present Westinghouse CS meter.

(2) This standardization applies only in matters of meter housing and connection terminals. It does not in any way concern the mechanisms and characteristics of the meter proper.

(3) The aim for the standard interchangeable meters, types A and S, will be the maximum simplicity and economy consistent with effective and satisfactory operation.

(4) The present Type B & C lines of equipment now manufactured by the General Electric, Sangamo, and Duncan Companies, will be continued.

Some question has been raised concerning the manufacturers offering two standards instead of one. It is generally felt, however, that this is desirable. Regardless of the type and design of a new meter mounting to meet the requirements as presented, there would undoubtedly continue an appreciable demand for an open terminal chamber, bottom connected meter interchangeable with and similar to those that have been used for several years. It will be a definite gain therefore for this meter to be standardized among all of the manufacturers, in addition to the fully standardized new method of mounting which fits in well with the modern trend in meter installations and service wiring.

Meter Purchases Can Now Be Planned

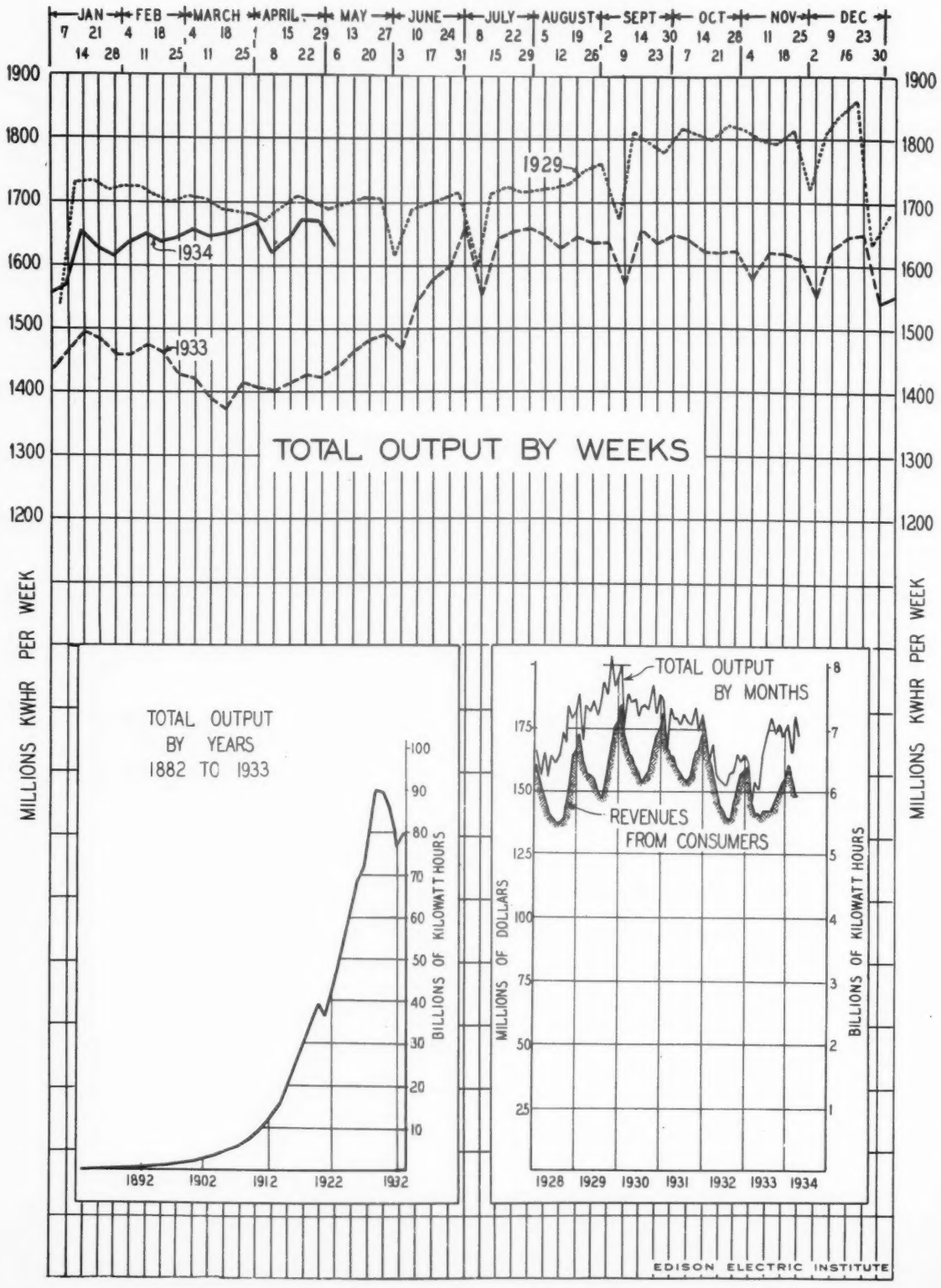
This agreement on meter standards clears the way for the operating companies intelligently to plan their house meter policies and pending purchases. It is in the simplification and unification of practices of meter installation and maintenance that the major opportunities for economies exist, although this unification should lead to substantial savings in the purchase price of the equipment. The users are counseled to give prompt, although deliberate, consideration to determining how best to realize the benefits available from this standardization. The earlier and more earnest the response to the new standards, as reflected by the purchases of the utilities, the sooner will the full benefits of consolidation and quantity production become available.

Coordination of Meter Mounting and Service Entrance

The very definite and increasing trend to the outdoor location for the meter emphasizes the need that meter mounting practices be coordinated with service entrance practices. This problem of service entrance practices, as noted in the April BULLETIN, has been included in the assignment of the Meter Mounting and Energy Diversion Subcommittees. The agreement on the Type A and Type S standard interchangeable meters clears up a major item, and enables concentrating on the service run and service entrance features.

POWER PRODUCTION IN THE UNITED STATES

(100 per cent of the electric light and power industry)



OPERATING EXPERIENCE WITH THE INTERCONNECTION OF PRIMARY LIGHTNING ARRESTER GROUNDS AND SECONDARY NEUTRAL

At the meeting of the Transmission and Distribution Committee in Cleveland on March 26, several companies reported experience with the interconnection of primary lightning arrester grounds and the secondary neutral. Inasmuch as this method of protection is comparatively new and for the most part has been practiced on a trial basis, the following experience should be of general interest.

COMPANY A.

During 1932-1933, direct interconnections of the lightning arrester ground wires and the transformer secondary neutral wire were made at six thousand locations. The interconnections were made only where the secondary neutral wire was grounded to two or more water pipes in customers' premises. The statistical data for troubles during thunderstorms are shown in Table I.

For both years, the effects of the interconnections were as follows:

(a) The rate of transformer failures and fuse blowings due to lightning was decreased about 65 per cent.

(b) No increase in troubles on customers' premises was reported as being due to the interconnection. (With normal arrester protection, the cost to the company for the damages on the customers' premises due to lightning averaged about $100 per year in 1930-31 when detailed investigations were made.)

(c) The rate of arrester failures due to lightning at the locations of the interconnections was about double the rate for locations where standard arrester protection was used. With interconnections, the rate of arrester failures has been about 25 per cent higher than the rate of transformer burnouts. (Complete use of the interconnection by the company would result in an increase of about 25 arrester failures a year.)

TABLE I—*(Company A)*

	1932		1933	
Total No. of Interconnections	3,000*		6,000*	
Total No. of Transformers Involved:				
(a) Standard arrester protection	27,500		21,840	
(b) Interconnections	5,700		10,990	
Total No. of Arresters Involved:				
(a) Standard arrester protection	27,690		22,320	
(b) Interconnections	5,450		10,730	
Troubles During Thunderstorms				
Standard Arrester Protection	*No.*	*Rate %*	*No.*	*Rate %*
Transformers burned out	95	0.323	97	0.371
Fuses blown	272	0.915	246	0.952
Total	367	1.238	343	1.323
Arrester Failures	25	0.086	20	0.081
Interconnections				
Transformers burned out	6	0.128	9	0.134
Fuses blown	15	0.302	22	0.333
Total	21	0.430	31	0.467
Arrester Failures	6	0.152	12	0.183
Reduction in Rates of Transformers burned out and fuses blown—%		65.2		64.7

*The interconnections were made in part during the lightning season; therefore, the data are pro-rated on the basis of the number of transformers with interconnections actually on the system during the periods of lightning trouble.

COMPANY B.

For the year 1933 the number of primary fuses blown expressed on a percentage of the total transformer installation was 8.7 per cent for all of our standard transformers on the system and 10.3 per cent for the 117 surge-proof transformers. Moreover in 1933 we had six cases of De-Ion gap failures on the 117 surge-proof transformers. In view of the fact that the surge-proof transformers have been installed primarily in outlying rural districts we may express the comparison between surge-proof

TABLE II—*(Company B)*

SUMMARY OF EXPERIENCE WITH DIFFERENT TYPES OF LIGHTNING PROTECTION

	Three Point Protection	Surge Proof Transformers	First Salted Grounds	4606 Feeder Ground Salted		4697 Feeder Ground Salted		Heavy Fusing Not Salted		Total Excl. Surrounding Feeders & Heavy Fusing
		Ground Not lowered	Salted to 30 ohms	Salted and lowered to 30 ohms	Surrounding not Salted	Salted and lowered to 30 ohms	Surrounding not Salted	Heavy Fused	Surrounding not Heavy Fused	
No. of locations	12	12	8	62	533	68	240	421	995	163
Date installed	8-6-32	7-22-32	9-10-31	3-1-32		4-1-32		6-1-31		
Primary fuses blown:								Note		
1931 before change	18	13	13	24	132	26	66	37	128	94
1932 before change	19	13	*	*		*		..	..	..
1932 after change	0	0	1	11	161	11	52	26	96	..
1933	3	7	1	5	106	12	63	20	99	28
Lightning Arrester Failures:										
1931 before change				No Record						
1932 before change	1	1	*	*	..	*		..	..	..
1932 after change	1	0	0	6	50	9	27	..	..	..
1933	1	5	0	0	40	7	31	..	..	..
Transformers Damaged:										
1931 before change	0	1	3	3	18	6	5	5	12	13
1932 before change	1	3	*	*		*		..	..	..
1932 after change	0	0	0	5	11	2	7	4	5	..
1933	0	0	0	0	10	1	8	1	6	1
Trans. Winding Failures:										
1931 before change	0	0	2	1	9	4	3	2	6	7
1932 before change	0	0	*	*		*		..	..	..
1932 after change	0	0	0	2	5	0	4	1	1	..
1933	0	0	0	0	5	0	4	1	3	0

*Installed before lightning season of 1932.

Note—No data available before heavy fuses installed.

transformers and the standard transformers based only upon standard transformers in the outlying areas. In this case the number of fuses blown was 15.8 per cent as compared with 10.7 per cent for the surge-proof transformers. A summary, Table II, gives the experience of this company with different types of lightning protection.

COMPANY C.

Operating experience with lightning arrester grounds bonded to the secondary neutral conductor at distribution transformer installation appears in Table III.

Interconnection was completed several years ago to the extent that it was practicable. Experience prior to interconnection is not available. A marked decrease in meter failures has been experienced in recent years. This is attributed partly to interconnection.

COMPANY D.
(See Table IV)

Interconnection was begun in 1932 and will be continued until completed.

COMPANY E.
(See Table V)

Transformer cases were grounded with interconnection. Fifteen failures were primary lead burnoffs, possibly due to grounded tanks. It is expected primary lead burnoffs will not be as frequent hereafter.

COMPANY F.
(See Table VI)

Interconnection has been regular practice for the past twenty-five years. Transformer cases have been grounded to the neutral conductor since 1931. An increase in transformer failures has been experienced since transformer cases were grounded.

COMPANY G.

Table VII gives for the year 1933 a record of troubles on single-phase distribution transformers in an outlying protected area. Interconnection has been established wherever there were three grounds on a secondary network.

From Table VII the effects of interconnection apparently were:

a. A decrease in trouble rate of 73.5 per cent.
b. An 87 per cent decrease in the cost of trouble.
c. An increase in meter troubles due to lightning. (The records do not show any increase of damage to customers' equipment due to the interconnection.)
d. A higher rate of lightning arrester failures.
The failure rate of one make and style is apparently much greater than that of the others.

COMPANY H.

Approximately 1300 distribution transformers on the 2300-volt distribution system have their arrester grounds interconnected with the secondary neutral. These installations include practically all arrester-protected transformers which feed 2 or more customers having water pipe secondary neutral grounds of 15 ohms or less and a driven arrester ground at the transformer pole. Experience with part of this group extends over a 3-year period.

The results of operating experience with the interconnection in 1933, which was an unusually severe lightning season, are summarized below:

Transformer Troubles

The rate of trouble at transformers with the interconnection was approximately 75 per cent less than at those without it. Even for the smallest and oldest transformers, a 66 per cent reduction in trouble was obtained by use of the interconnection.

TABLE III—*(Company C)*

	Interconnected Arresters	*Without Interconnected Arresters*
Average number of transformers, 1932 & 1933	734	18
Transformer failures due to lightning, 1932 & 1933	2	1
Rate of failure (per 100 per year), 1932 & 1933	.13	2.75
Lightning arrester failures, 1932 & 1933	11	0

TABLE IV—*(Company D)*

	Interconnected Arresters	*Without Interconnected Arresters*
Number of transformers, 1933	1432	8275
Transformer failures due to lightning, 1933	0	55
Rate of failure (per 100), 1933	0	.666
Lightning arrester failures, 1933	2	0

TABLE V—*(Company E)*

	Interconnected Arresters	*Without Interconnected Arresters*
Number of transformers, 1933	3780	..
Transformer failures due to lightning, 1933	28	..
Rate of failure (per 100), 1933	.74	..
Rate of failure average for 1927 to 1930 inclusive	..	.55
Lightning arrester failures, 1933	4	..

TABLE VI—*(Company F)*

	Interconnected Arresters
Average number of transformers, 1930-1932 inclusive	2100
Transformer failures due to lightning, 1930-1932 inclusive	5
Rate of failure (per 100 per year), 1930-1932 inclusive	.08
Rate of failure (per 100 per year), 1923-1930 inclusive	.05
Lightning arrester failures, total, 1930-1932 inclusive	8

TABLE VII—*(Company G)*

	Interconnected Arresters	*Standard Arresters*	*No Arresters*
No. of transformers	3666	847	518
Transformers burned out	9	24	13
Transformers burned out/100 trans	.25%	2.84%	2.51%
Misc. troubles, fuses, etc.	118	85	61
Misc. troubles/100 trans	3.21%	10.04%	11.78%
Total troubles	127	109	74
Total troubles/100 trans	3.46%	12.88%	14.29%
Trouble cost/100 trans	$33.30	$257.70	$288.90

Arrester Trouble Rate by Lightning

	Appro. No. Involved	*Failure Rate*	*Appro. No. Involved*	*Failure Rate*
Make A	3300	0.12%	830	0.00%
" B type 1	1800	0.22	400	0.24
" " " 2	500	2.65	100	1.84
" C " 1	1200	0.17	350	0.00
" " " 2	500	0.00	...	...
Meter Failures by Lightning				
Meter failures	104		5	12
Meter failures/1000 kva trans. cap.	2.05%		.92%	1.80%

A comparison of troubles with and without the interconnection is given in Table VIII.

Meter Troubles and House Fuse Blowings

From limited experience, it has been found that the interconnection has not increased consumer meter lightning troubles. Table IX is a summary of this experience for a part of the 1933 lightning season. Approximately 475,000 meters are involved in the area studied.

Likewise, there appears to be no definite tendency for increase in house fuse blowings as determined from an investigation of 154 cases selected at random over a large area after a severe lightning storm. This limited investigation further revealed that practically all of the house fuse blowings occurred at 500 feet or more from the transformers, thus indicating that they were probably due to surges originating on the secondaries rather than from discharges, primary to secondary, through the arrester interconnection at the transformers.

Arrester Failures

The majority of the 3100 arresters on distribution transformers are rated at 6 kv. In 1933, 12 units or 0.4 per cent failed during lightning storms, while none were reported damaged during other periods. Of the 12 cases, 9 were on the 1333 interconnected transformers, and 3 on the 324 protected transformers not having the interconnection. Thus, the rate of failure was no greater at transformers with the interconnection than at others. The number of cases involved may not be sufficient to draw final conclusions, but to date the interconnection has not caused increased arrester failures.

Arresters on Line Side of Cutouts

On the 2.3 and 4 kv distribution systems lightning arresters are connected on the line side rather than on the transformer side of the fuse cutouts. The principal reason for this practice is to maintain lightning protection for the cutout even after the fuse has blown.

There is generally sufficient capacity so that faulty arresters either blow up or burn clear of the circuit without the need of any fuse protection. Connection on the line side of the cutout therefore reduces the number of service interruptions resulting from blown fuses. Furthermore, the distribution transformers in general are fused only for short-circuit protection to increase service reliability, and such high capacity fuses would probably be of little or no use as protection in clearing the relatively infrequent case of an arrester which develops a long continued high resistance fault.

TABLE VIII—*(Company H)*—FUSE, FUSE BOX AND TRANSFORMER TROUBLE DUE TO LIGHTNING—1933

		Cases of Trouble			*Troubles per 100 Transformers*		
	No. of Transf.	*Fuse and Fuse Box*	*Transf.*	*Total*	*Fuse and Fuse Box*	*Transf.*	*Total*
With Interconnection	1333	5	13	18	0.37	0.98	1.35
Without Interconnection	6753*	139	207	346	2.06	3.07	5.13
Total	8086	144	220	364	1.78	2.72	4.50

*324 of these have arresters, and because of their small size and location in outlying sections of the city experienced about as much trouble as unprotected transformers.

TABLE IX—*(Company H)*—METER TROUBLES, MAY 1 TO JUNE 15, 1933

	Transformers Supplying Meters	*Meter Troubles*	*Meter Troubles per 100 Transformers*
With Interconnection	1333	17	1.3
Without Interconnection	6753	163	2.4
Total	8086	180	2.2

COMPANY I.

As a result of trial installations of interconnected transformer and secondary neutral grounds made during the year 1932, the decision was made to equip all transformers not so equipped with lightning arresters and to interconnect all lightning arrester and neutral grounds in our territory outside of the city district.

The work of installing arresters on all transformers in the suburban district not already equipped with arresters, and interconnecting the arrester ground and transformer neutral at all locations was begun early in 1933 and was in progress during the entire year. It was estimated to have been 90 per cent completed on July 1, and is now completed except for a few scattered locations.

The lightning season was particularly severe in 1933, both as to the number of storms and their severity. Interruption on the 24,000 volt system may be taken as an indicator of storm severity when compared to those of previous years. Interruptions due to lightning since 1929 for the 24,000 volt and the 4800 volt systems for the city and suburban districts are shown in Fig. 1. It will be noted that there was a greater number of failures on the 24,000 volt system in 1933 than for any other year except 1931, although some improvement has been made in lightning protection since 1931. Interruptions on the 4800 volt system in the city and suburban districts follow the trend of 24,000 volt interruptions prior to 1933. Each year there have been a greater number of interruptions in the suburban district than in the city district until 1933 when interruptions in the suburban district were even fewer than in 1932. From this it is concluded that the interconnection and installation of arresters on all suburban distribution transformers have added protection to the line as well as to the transformers. 4800 volt interruptions, therefore, cannot be taken as a reflection of storm conditions in the suburban districts.

Distribution Transformer Failures

The distribution transformer failures due to lightning for the last three years are shown in Table X.

TABLE X—*(Company I)*

	1931	*1932*	*1933*
Suburban, with arresters not interconnected	214	217	96
Suburban, with arresters interconnected	...	...	149
Suburban, without arresters	135	274	75
City, with arresters not interconnected	34	29	44
Location unknown	50	42	36
Total	433	562	400

TABLE XI—*(Company I)*

	Suburban	*City*	*Total*
Transformers with arresters	22,800	15,900	38,700
Transformers without arresters	5,000	...	5,000
	27,800	15,900	43,700

The approximate number of transformers on the system as of Jan. 1, 1933, is shown in Table XI.

Fuse Outages

The number of fuses blown during 1933 showed a very marked decrease over 1932, especially during the latter part of the lightning season. A great deal of this reduction was due to the installation of lightning arresters on the 5000 transformers on farm lines not so protected, but the interconnection undoubtedly helped considerably. There were about 4900 blown fuses in 1932 and about 2900 in 1933.

The charts in Figs. 2 and 3 show the effect of the gradual installation of lightning arresters on farm lines and the interconnection of grounds on transformers and fuse outages.

Arrester Performance

The effect of the interconnection on the failures of lightning arresters has not been marked enough to draw any definite conclusions as yet. The question has been raised as to whether the interconnection has increased the number of fuse outages on customers' premises and also the number of meter failures. We are able to find no evidence of any marked increase in fuse outages and the

(Continued on page 156)

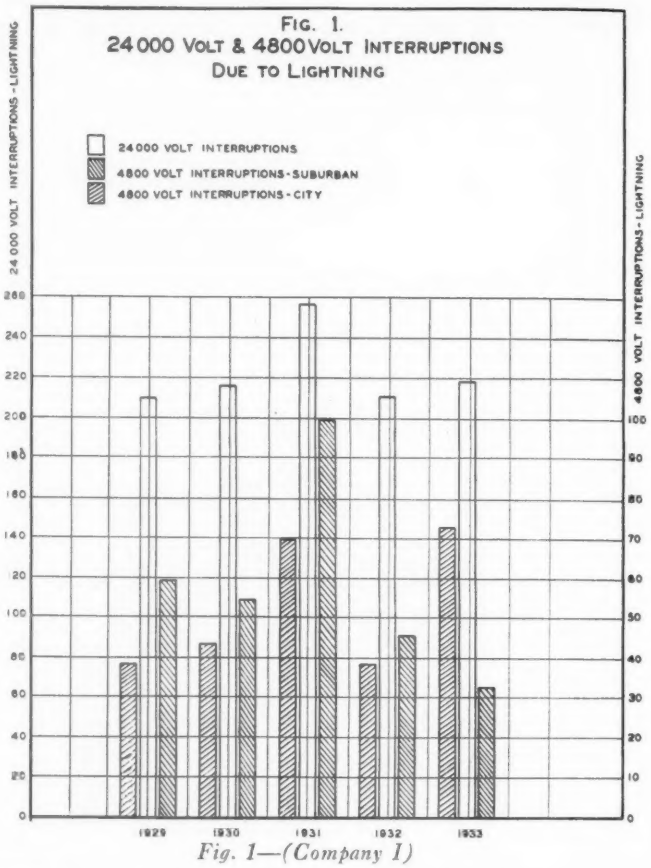


Fig. 1—(Company I)

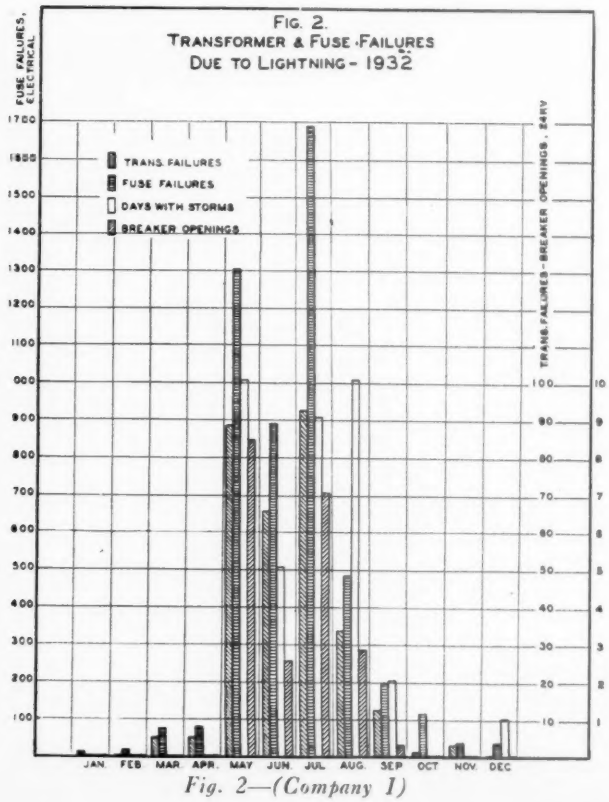


FIG. 2.
TRANSFORMER & FUSE FAILURES
DUE TO LIGHTNING - 1932
FUSE FAILURES, ELECTRICAL
TRANS. FAILURES
FUSE FAILURES
DAYS WITH STORMS
BREAKER OPENINGS
TRANS. FAILURES - BREAKER OPENINGS, 24 KV
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

Fig. 2—(Company I)

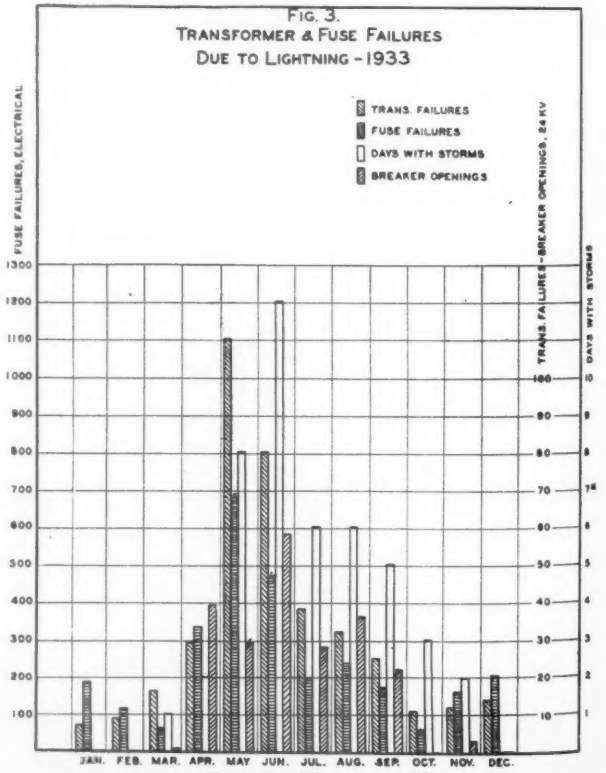


FIG. 3.
TRANSFORMER & FUSE FAILURES
DUE TO LIGHTNING - 1933
TRANS. FAILURES
FUSE FAILURES
DAYS WITH STORMS
BREAKER OPENINGS
FUSE FAILURES, ELECTRICAL
TRANS. FAILURES - BREAKER OPENINGS, 24 KV
DAYS WITH STORMS
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

Fig. 3—(Company I)

OPERATING EXPERIENCE IN CONNECTION WITH DISTRIBUTION TRANSFORMERS, FUSES AND LIGHTNING ARRESTERS

On the Minneapolis 4 KV Common Neutral Grounded System, Using the "Interconnection" Method of Lightning Arrester Grounding Both on Urban and Rural Lines

By D. M. BUNN and M. T. JAMIESON

Superintendent of Distribution and Distribution Engineer, respectively, Northern States Power Company, Minneapolis District

Presented at Meeting of Transmission and Distribution Committee, E.E.I., Cleveland, Ohio, March 26, 1934.

During the past several years engineers from many utilities have made inquiries regarding the use of our 4 kv common neutral grounded system of distribution as well as inquiries regarding our operating experience while using lightning arrester grounding by interconnection. In order that we might know, as well as to obtain information which might be of interest and benefit to the electrical industry in general, we have kept records of distribution operating data which would either prove, or disprove, our theories regarding this type of distribution system.

From these records it is now possible to determine the total number, the percentages and the cause of transformer, fuse and lightning arrester interruptions and failures.

The following data cover some of the records as kept for the year 1933 as well as a few summaries and comparisons of reports of previous years.

In analyzing these figures, the following pertinent facts should be kept in mind: The transformers covered in this report are all protected by lightning arresters and primary fuse cutouts fused, for the most part, at one ampere per kv-a. The lightning arresters are connected to the primary on the line side of the transformer fuse cutout and the ground lead is connected to the neutral wire which is the common ground wire for the secondary system as well as the 4 kv star connected primary system. The resistance to ground of this common neutral wire, in the vast majority of cases, is less than 1 ohm and rarely over 3 ohms.

The grounding practice used is shown in Fig. 1. The 1933 Distribution Transformer and Transformer Fuse Operation Record for the Minneapolis Division is shown in Fig. 2.

The Minneapolis District has an approximate area of 510 square miles, served at present by 5,866 distribution transformers. Of this number, 13 transformers, or .22 per cent, were burned out due to all causes during the year 1933. The record shows, in detail, the various sizes and the conditions responsible for the transformer failures. Considering the fact that only 3 distribution transfomers, or .051 per cent of the total number of transformers, were burned out due to lightning, it seems quite conclusive evidence that the lightning arrester connections, as used by this Company since 1920 and which have in the past few years become commonly known as lightning arrester grounding by interconnection, are highly satisfactory.

TABLE I:

COMPARATIVE RECORD OF TRANSFORMER BURNOUTS

Minneapolis Division, Excluding Minnetonka District

1920 to 1933, Inclusive

Year	Total No. of Transf. in Serv.	No. of Burnouts Due to all Causes	% of Burnouts of Total No. of Transf.	No. of Burnouts Due to Lightning	% of Total No. of Burnouts Due to Lightning
1920	2855	45	1.58		
1921	2921	51	1.75		
1922	3183	40	1.26		
1923	3269	16	.49		
1924	3188	41	1.28		
1925	3428	58	1.69		
1926	3950	25	.63		
1927	4032	15	.372		
1928	4225	15	.355	9	60.0
1929	4679	7	.150	2	28.6
1930	4937	16	.344	5	31.3
1931	5402	13	.241	6	46.2
1932	5667	9	.158	7	77.8
1933	5866	13	.222	3	23.0

Table I gives figures taken from annual reports since 1920. These figures show a marked decrease in transformer failures and we feel that it is a remarkably good transformer operating record.

That portion of the 1933 Transformer Record headed "Minnetonka District" includes 837 transformers. The Minne-

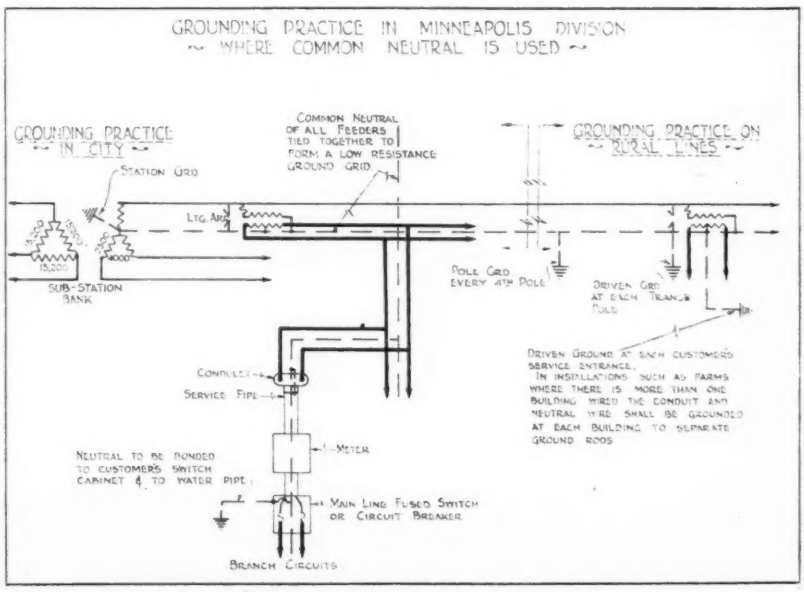

GROUNDING PRACTICE IN MINNEAPOLIS DIVISION
WHERE COMMON NEUTRAL IS USED
GROUNDING PRACTICE IN CITY
COMMON NEUTRAL OF ALL FEEDERS TIED TOGETHER TO FORM A LOW RESISTANCE GROUND GRID
GROUNDING PRACTICE ON RURAL LINES
STATION GRID
LTG. ARR.
13,200
4000
SUB-STATION BANK
POLE GRD. EVERY 4TH POLE
DRIVEN GRD. AT EACH TRANS. POLE
DRIVEN GROUND AT EACH CUSTOMERS SERVICE ENTRANCE. IN INSTALLATIONS SUCH AS FARMS WHERE THERE IS MORE THAN ONE BUILDING WIRED THE CONDUIT AND NEUTRAL WIRE SHALL BE GROUNDED AT EACH BUILDING TO SEPARATE GROUND RODS
CONDUIT
SERVICE PIPE
METER
NEUTRAL TO BE BONDED TO CUSTOMERS SWITCH CABINET & TO WATER PIPE
MAIN LINE FUSED SWITCH OR CIRCUIT BREAKER
BRANCH CIRCUITS

Fig. 1

tonka District is a suburban area which includes several small communities, summer resorts, and rural territory surrounding the Minnetonka lakes. The approximate area of this district is 130 square miles.

The changing of the Minnetonka District primary distribution system from 2300-v delta to 4 kv star common neutral grounded system has been under way for several years and was just completed in 1932. This is the first complete transformer and fuse operation report made under these conditions.

With a total of 3 transformer burnouts, or .35 per cent of the total of 837 transformers, it appears that this area will compare very favorably with the Minneapolis area as to percentage of transformer burnouts due to all causes. Although there were 2 burnouts due to lightning, .23 per cent of total transformers, both were due to direct strokes, one being on the primary system and one on the secondary service from the transformer. Considering the fact that this entire area has relatively few grounds on the common neutral system as compared to the Minneapolis District, the results seem very gratifying.

Prior to 1927 when this Company purchased the distribution system in the Minnetonka District, it was not required that the consumer have a ground on the secondary neutral at his service entrance. All new customers connected since 1927 have been required to supply a ground at the service entrance and a large number of individual driven grounds were installed at transformer locations at the time the changing over of the primary system from delta to 4 kv common neutral grounded system took place.

In checking over our records in regard to the number of meter burnouts due to lightning, I find that when the system was operated at 2300 volts delta there was an average of 15 burnouts per year due to lightning.

Since the system has been cut over to 4 kv common neutral grounded system, we have had an average of 8 burnouts per year, with a maximum of 5,000 meters in service.

It will also be interesting to note that with the 4 kv common neutral grounded system, we have not lost a meter where the service is of the present approved grounded type. All losses have occurred on ungrounded services.

Another argument in favor of the 4 kv common neutral grounded system is our experience with a farm line. This line is about 2 miles long, built with bare 3-strand number 10 copper primary on 4 pin cross-arms. During the time we operated this line at 2300-v it was hit a great many times. In some cases only transformer fuses were blown; in others, equipment was damaged. We have a record of 2 transformers, 2 lightning arresters, 1 pole, and 3 cross-arms being destroyed by lightning on this line. Since the line has been changed over to 4 kv common neutral grounded system, using interconnection method of lightning arrester grounding, we have not had so much as a blown transformer fuse.

It is also of interest to note that since changing over the Minneapolis distribution system of primaries from 2300-v delta to 4 kv star, using common neutral grounded system and the interconnected lightning arrester grounds, the number of meter potential coils burned out due to lightning has been materially reduced.

The successful and safe operation of either the common neutral system or any system using the so-called "interconnection" method of lightning arrester protection depends on the adequacy of the grounding system. It is a well established fact that where a multiplicity of water pipe grounds exists on the secondary services, as is the case in urban districts, the resistance to ground of the neutral conductor is very low and furnishes a highly reliable lightning arrester ground.

The changing of the Minneapolis city distribution feeders from 2300-v delta to 4 kv common neutral grounded system was carried over for a number of years and was completed in 1924. At that time a survey was made over the city and the ground resistance taken at 122 locations. The highest resistance at that time was 1.5 ohms. The lowest was 0.10 ohm. Since that time hundreds of additional ground connections to the common neutral have been made through the connection of new customers.

Our operating experience, as indicated in the above records, has been practically ideal and is, for the most part, due to the reliability of the ground system.

In the minds of many engineers the advisability of using the interconnection method of lightning arrester protection on rural lines is rather questionable. Our rural line experience, however, has been highly satisfactory while using the interconnection in conjunction with our common neutral system. Approximately 700 miles of suburban and rural lines

MINNEAPOLIS DIVISION

SIZE OF TRANSFORMER	½	2	3	5	7½	10	15	20	25	30	37½	40	50	75	100	150	200	300	500	Total No. of Transf & Fuses	Total Kv-a	
NUMBER IN SERVICE	110	21	581	647	408	815	1809	423	552	117	375	26	273	110	113	43	10	35	24	5866		
Total Kv-a	165	42	1743	3235	3015	8150	18125	8460	13800	3510	18683	1040	13650	8250	11300	6862	2000	9600	12000		133508	
% of Total Transformers	1.87	.36	9.91	11.05	6.95	13.89	30.81	7.21	9.41	1.99	6.39	.44	4.66	1.88	1.93	.73	.17	.26	.41			
% of Total Kv-a	.12	.03	1.31	2.42	2.26	6.10	13.58	6.34	10.34	2.63	10.54	.78	10.22	6.18	8.46	5.13	1.50	7.19	8.99			
NO. TRANSF. FUSES BLOWN DUE TO																						% of Total Fuses Blown
Overload				1	3	21	1		3	5										34	4774	22.6
Shorts on Sec. or Cust. Wiring				5	8	9	12	3	5				1	1						58	620	29.5
Shorts caused by Bldg. Fires				2	1	7	4						2							16	1574	7.6
Lightning			4	3	2	5	2													16	122	10.7
Faulty Equipment						1				1										2	50	2.0
Cause Not Known			4	5	3	14	10	1	1	2	1		3		1					45	746	31.6
TOTAL			8	16	17	58	30	4	9	8	1		6	1	1					199	2234	2.54(% of Total No.Fuses)
NO. TRANSF. BURNED OUT DUE TO																						% of Total Transf. Burned Out
Overload	1		1		2					1				1						6	1241	46.2
Shorts on Sec. or Cust. Wiring					1					1										2	371	15.4
Lightning	1			1		1														3	189	23.0
Cause Not Known						1	1													2	75	15.4
TOTAL	2		1	1	3	2	1			2				1						13	2034	.222 (% of Total Transf.)

(NOTE: Two Bushings were Destroyed by Lightning but Transformers were not Burned Out)

LAKE MINNETONKA DISTRICT

NUMBER IN SERVICE	69	12	182	250	104	152	39	1	15	1	6		1		3					837		
Total Kv-a	103	24	546	750	780	1520	585	20	375	30	300		50		300						5883	
% of Total Transformers	8.2	1.5	21.7	29.8	12.5	18.2	4.7	0.1	1.8	0.1	1.0		0.1		0.3							
% of Total Kv-a	1.7	0.4	9.3	21.2	13.3	25.9	9.9	0.3	6.4	0.5	5.1		0.9		5.1							
NO. TRANSF. FUSES BLOWN DUE TO																						% of Total Fuses Blown
Overload			1	4		1			1											7	58	29.1
Short on Sec. or Cust. Wiring	1		1	2	1	5														10	72	41.6
Short Caused by Bldg. Fires				1																1	5	9.2
Lightning	2		1	1																4	13	14.7
Cause Not Known			1	1		1														2	35	8.6
TOTAL	3		3	9	1	7			1											24	183	2.87(% of Total No.of Fuses)
NO. TRANSF. BURNED OUT DUE TO																						% of Total Transf. Burned Out
Overload			1																	1	3	33.3
Lightning	1		1	(3 Kv-a Burn Out Due to Lightning Jumping From Tree to Trans. Single Service)																2	44	66.7
TOTAL	1		2																	3	79	.358 (% of Total Transf.)

Fig. 2—Transformer Record, 1933. Minneapolis Division, Excluding St. Croix District

of this type are now giving practically uninterrupted and hazard-free service in the Minneapolis Division.

A review here of a few of our operating experiences with this type of lightning arrester protection may help to substantiate our views as to the safety of these lines.

During a severe windstorm, two poles carrying a 66 kv transmission line, 4 kv rural farm line and a company telephone circuit broke, resulting in the 66 kv lines falling and lying on the 4 kv common neutral rural line and the telephone circuit. After the 66 kv line had tripped out, the station operator reclosed the 66 kv circuit breaker which resulted in the second discharge into the 4 kv common neutral system. The only damage done on the distribution system was the blowing of the primary sectionalizing fuse on the station side of the fault, the complete shattering of three lightning arresters which were grounded to the common neutral at three single-phase transformer installations within ¾ mile of the short circuit, and the welding of the contacts on one snap switch as well as several burned out lamps at the nearest customer who was only three spans away and the only customer connected to the transformer.

It seems only reasonable to believe that, because of the fact that the lightning arresters all along this rural line were tied into the low resistance common neutral ground, these two 66 kv surges were dissipated and the potential held down on this 4 kv system to such a low value that no material damage was done. There were no transformer or customers' fuses blown during this storm.

Table II shows a number of ground tests made on the common neutral as well as isolated driven grounds installed along a range of hills which is probably the highest elevation near Minneapolis in the vicinity where this storm struck our line, causing the 66 kv line and the 4 kv rural farm line to get together.

Figs. 3 and 4 show results of a field check on grounds following direct strokes of lightning, causing damage to poles. In neither case was there any fuse blowing or damage caused to customers' equipment or wiring. It will be noted in Fig. 3 that two lightning arresters were destroyed at this location due to the severity of the lightning discharge.

We have often been asked how many cases of failure of customers' equipment and wiring we have had on our system, also the number of accidents, which can

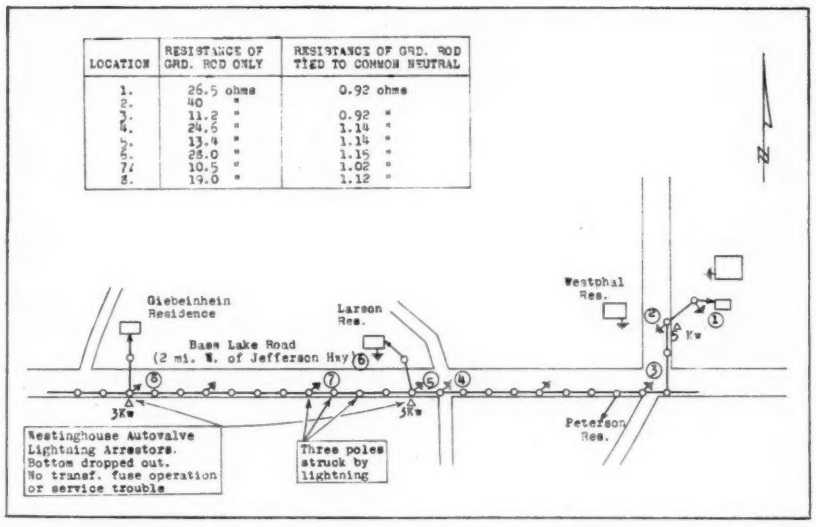

LOCATION
RESISTANCE OF GRD. ROD ONLY
RESISTANCE OF GRD. ROD TIED TO COMMON NEUTRAL
1. 26.5 ohms 0.92 ohms
2. 40 " "
3. 11.2 " 0.92 "
4. 24.6 " 1.14 "
5. 13.4 " 1.14 "
6. 28.0 " 1.15 "
7. 10.5 " 1.02 "
8. 19.0 " 1.12 "
N
Giebelhein Residence
Larson Res.
Base Lake Road (2 mi. W. of Jefferson Hwy)
Westphal Res.
5 Kw
3Kw
3Kw
Peterson Res.
Westinghouse Autovalve Lightning Arrestors. Bottom dropped out. No transf. fuse operation or service trouble
Three poles struck by lightning

Fig. 3—Grounding investigation following a lightning storm on a 2300-volt common neutral system rural line.

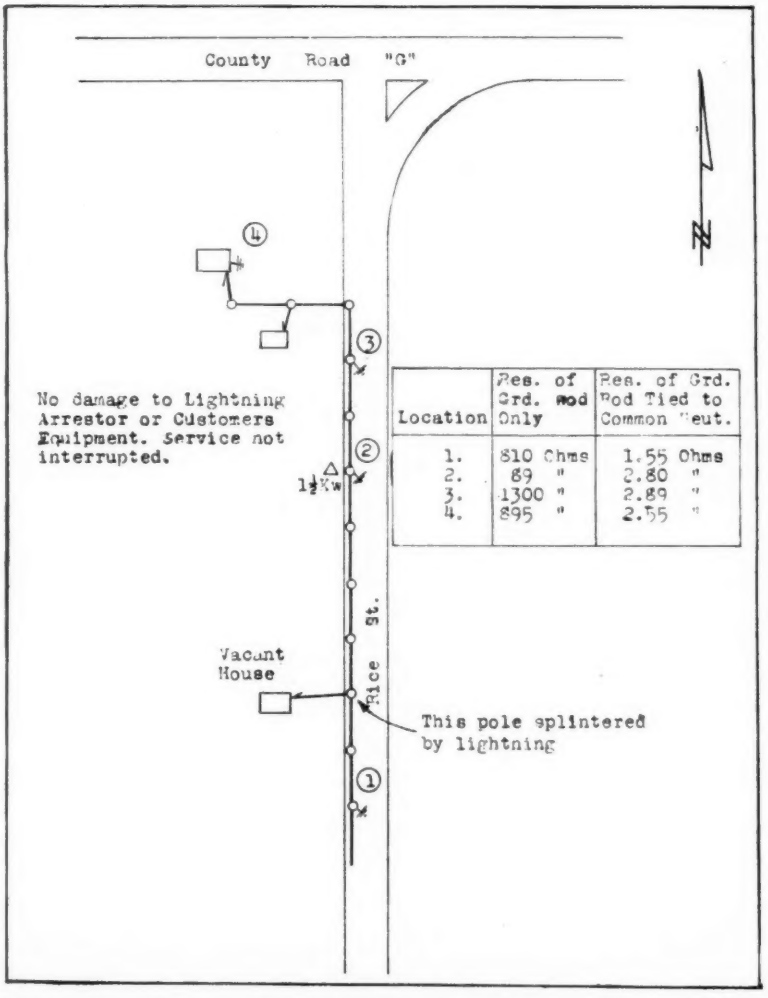

County Road "G"
N
No damage to Lightning Arrestor or Customers Equipment. Service not interrupted.
1½ Kw
Location
Res. of Grd. Rod Only
Res. of Grd. Rod Tied to Common Neut.
1. 810 Ohms 1.55 Ohms
2. 89 " 2.80 "
3. 1300 " 2.89 "
4. 895 " 2.55 "
Rice St.
Vacant House
This pole splintered by lightning

Fig. 4—Grounding investigation following a lightning storm on a 2300-volt common neutral system rural line.

TABLE II:

WILLISTON PARK ROAD—GROUND TESTS

General Elevation: One of the Highest and Most Irregular Ridges Near Minneapolis

Location	Date of Test	Neutral With Pole Grd. On	Neutral With Pole Grd. Off	Pole Grd. (Measured On Wire)	Pole Grd. (Measured On Pipe)	Kind of Ground Rod
		Resistance—Ohms				
1	10-15-30	.6	.62	25.5	25.5	Copperweld
2	10-15-30	1.15	1.24	18.7	18.7	¾" Pipe
3	10-15-30	.62	.62	47.7	47.7	½" Pipe
4	10-15-30	.85				
5	10-15-30	1.7	1.8	94	94	¾" Pipe
6	10-15-30	1.35	1.4	275	275	¾" Pipe
7	10-15-30	4.1	4.2	58	58	2-¾" Pipes 6 ft. apart
8	10-15-30	4.1	4.2	120	120	¾" Pipe
9	10-15-30	1.2	1.26	34.7	37.7	Copperweld
10	10-15-30	3.2	3.2	256	256	¾" Pipe

be traced to excessive voltage being introduced on customers' premises.

We find, by checking with the city electrical inspector and with our own Service Department, that there has not been a single case of trouble or damage to interior wiring due to excessive voltage which has been experienced since the common grounded neutral and the interconnection method of lightning arrester grounding has been in general use throughout the city. During this time we have had experience with the 4 kv primaries crossing up with secondary wires and services during storms, 13 kv short circuits to the 4 kv primaries as well as having had a number of lightning arresters completely broken down due to lightning and other causes such as water getting into the arrester, causing corrosive deposits to close the spark gap and resulting in a primary power current flowing into the common neutral. In many of such cases the arresters have been completely destroyed; while, in other cases, the primary or ground lead would burn off or the feeder circuit breaker would open at the substation. In none of these cases has any trouble been experienced on the customers' interior wiring or equipment due to excessive voltage.

On our suburban and rural lines, neither our own wiring inspector nor the Service Department has any records of any damage having occurred on customers' wiring due to excessive voltage because of lightning arresters being connected to the common grounded neutral.

The tabulation of ground tests made at random on our rural 4 kv common grounded neutral lines (Table III) indicates the superiority of this system of multiple grounding as compared to individual ground rods.

TABLE III:

RESISTANCE IN OHMS OF THE COMMON NEUTRAL AND ISOLATED GROUND RODS TO GROUND (½"-10 FT. RODS)

Location No.	Date of Test	Neutral and Rod Together	Rod Separate	Kind of Soil	Condition of Soil
1	7- 1-32	1.02	20.0	Sand	Dry
2	7- 1-32	.82	13.7	Peat bog	Moist
3	7- 1-32	1.17	170.0	Sandy clay	Damp
4	7- 1-32	1.91	12.3	Clay	Moist
5	7- 1-32	2.02	34.0	Clay	Moist
6	7- 1-32	2.12	42.0	Sandy clay	Moist
7	7- 1-32	1.39	12.7	Clay	Moist
8	7- 1-32	1.12	29.5	Peat bog	Moist
9	7- 1-32	1.47	89.0	Sand and clay	Moist
10	6-23-32	1.52	11.5	Yellow clay	Moist
11	6-24-32	1.22	17.0	Sandy loam	Moist
12	6-23-32	1.07	19.5	Sandy loam	Moist
13	6-23-32	1.02	14.0	Yellow sand and clay	Moist
14	6-23-32	.82	12.5	Sand	Moist
15	6-24-32	.87	20.6	Sandy loam	Moist
16	6-24-32	.79	15.0	Sandy loam	Moist
17	6-24-32	.72	11.0	Sand and clay	Moist
18	6-24-32	.82	11.5	Sand and clay	Moist
19	6-24-32	.92	10.7	Sandy clay	Moist
20	6-24-32	.92	9.5	Clay	Wet
21	6-24-32	.99	13.4	Sandy loam	Moist

The following 1933 record of various makes of distribution lightning arresters shows the number of replacements of each make of arrester and, to a certain degree, indicates the durability of the different makes (Table IV).

TABLE IV:

Manufacturer	No. in Service	Replacements for all Causes	% of Total of each make
A	3921	19	.48
B	1578	20	1.20
C	895	11	1.23

The arresters indicated above include all of those replaced for such reasons as radio interference, mechanical breakage and electrical burnouts due to corrosion within the arrester as well as those destroyed by direct strokes of lightning. The latter cause is the one which is responsible for the majority of failures of arresters as well as transformer failures.

A list of publications of the Institute will be sent upon request to

EDISON ELECTRIC INSTITUTE
420 Lexington Ave., New York, N. Y.

Operating Experience With the Interconnection of Primary Lightning Arrester Grounds and Secondary Neutral

(Continued from page 152)

meter failures due to lightning showed a slight decrease last year.

We are quite certain that the interconnection of grounds has decreased our transformer failures and outages due to fuse blowing, although the installation of lightning arresters at the same time makes it difficult to say quantitatively how much of the improvement in service is due to interconnection and how much due to the installation of arresters.

COMPANY J.

Quantitative data for the past lightning season cannot be analyzed exactly since the work of making interconnections progressed during the lightning season although there appears to be a definite trend toward decreased outages.

In 1932 there were 1006 fuse operations on 4016 transformers or 25 per cent. In 1933 there were 1625 fuse operations on 5413 transformers or 30 per cent. The weighted average of these two seasons is 28 per cent. Of the 855 interconnected installations, there were 16 fuse operations or 1.87 per cent. As stated above, only a portion of these transformers were exposed during the 1933 season so that a performance ratio cannot be obtained.

The greater efficiency of the interconnection has increased the duty of lightning arresters. We do not feel that this increase requires any change in design of the modern arresters available since we doubt that an arrester could be designed to withstand a severe direct stroke. Any increased cost for distribution arresters is undesirable since their use at present is based on service requirements rather than economic consideration in the protection of small transformers. In the analysis, there were only three cases of damage to arresters on interconnected installations. The majority of arrester failures have been caused by entrance of moisture either due to dry process porcelain or improper sealing of gap chamber.

We are proceeding with the direct interconnection as rapidly as practicable on transformers feeding lighting customers whose services are grounded by a continuous underground water system.

Where customers' services are not so grounded, we are installing a "neutral gap" arrester, connected between secondary neutral and the primary arrester ground wire. This arrester has a gap setting of 5 kv at 60 cycles.

PRIMARY DISTRIBUTION ECONOMICS AND ITS RELATION TO DISTRIBUTION COSTS

By E. R. HENDRICKSON
Public Service Company of Northern Illinois

Presented at meeting of Transmission and Distribution Committee, E.E.I., Cleveland, March 26, 1934.

General Considerations in Economic Studies

Because of the constantly changing character of the load, problems of economical design usually involve transient rather than static phenomena. Most studies which have been previously made have not given proper consideration to this point. In general, they have been based upon the assumptions that a certain constant load was to be served. They give the correct answer for the most economical method of serving such a load, but they do not take into consideration the changing character of the load nor the fact that what is really desired is the most economical service over a period of years. This appears to be one of the major points which needs reemphasizing in most distribution design work. The importance of this fact has already been recognized in studies made by Mr. Merrill DeMerit and other leading distribution engineers.

The usual method followed in the past of giving consideration to the change in the character of load has been the preparation of a series of designs for periodic intervals, each based upon the estimated load to be served at that time. By taking into consideration the costs for each successive change in the system and totalizing them on the present worth basis a satisfactory picture of the total overall costs of various systems under consideration is obtained.

This plan of solving such problems, however, involves a very large amount of detailed work because of the numerous layouts and estimates which must be made for each successive year. It would appear that possibly some attention might be given to the obtaining of a mathematical expression (in which one of the variables would be the expected rate of load growth), to cover the economical design of various features of a distribution system, such as size of secondary, primary voltage, etc. Such an expression would enable the average engineer to obtain a clear picture of the fundamentals underlying the true economics of any individual case, and would avoid the necessity of doing such a large amount of detailed work. I am not sure that such an expression could be developed in a sufficiently simplified form. However, from work done in connection with the Secondary Design Subcommittee on this problem, I believe that the possibilities of obtaining a satisfactory expression warrant its being given serious study by a qualified mathematician.

In any problem of primary design there are a number of features which are more or less fixed, and whose value must be established before the actual work of evaluating the variables may begin. This will include items affecting the quality of service, such as limits of voltage regulation, expected service continuity, etc. There is also another class of items which will be fixed for any individual case, but which must be evaluated and definitely established before the work can be completed. For primary feeder work these will cover items such as (1) proper relationship between feeder costs and regulator costs, (2) type of primary system to be used, etc. This leaves a third class of items as direct variables. The most outstanding item of this class, and the one with which engineers are most concerned in primary design, is that of the feeder voltage. The other factors, such as size and type of conductor, etc., are more or less dependent upon voltage used.

Conditions Under Which Higher Voltage is Economical

It has been recognized by Mr. DeMerit that a voltage higher than 2300/4000 will usually only be more economical at locations where (1) a large number of power circuits are required, (2) where the system is large enough to permit the elimination of a substation if higher voltage feeders were to be used, (3) where the average load density is high, on the order of 150-300 kw. per one thousand feet. Studies which have been made for the Public Service Company system tend to confirm these conclusions. We believe, however, that there is one additional factor which should also receive mention in this connection.

In the general discussion of the use of higher voltage for distribution feeders it is usually assumed by most engineers that only the standard radial type distribution is considered. A closer examination of the above instances where higher voltage may be more economical will show that in general their use would justify some other form of service such as some type of a network, automatic throwover, or loop service.

In the case first mentioned where a number of power circuits are necessary from a substation, the power load would undoubtedly be of considerable consequence, and would involve a number of large customers. The higher voltage feeders used in this case would most usually take the form of at least semi-transmission lines, and would probably be equipped with some form of automatic sectionalizing devices for the larger customers so that they could be operated as a closed loop.

A system such as mentioned under the second point, where a substation could be eliminated by the utilizing of higher voltage feeders could probably also be served as well, and possibly more economically, but the use of a primary network if the load were not too scattered. The feeders would then take the form of transmission lines to various primary network units.

However, if the load were so thin as to approach rural conditions, and if it extended over a considerable area, higher voltage radial feeders might easily be warranted, especially if much additional transmission line costs would be incurred in the erection of the additional substations which would be required to provide service at the lower voltages. This then becomes a problem of rural line economics, and its solution depends largely upon the relation between distribution transformer costs and the additions required to the transmission system to provide additional step-down substations to supply the larger voltage feeders. Our studies indicate that in territory where transmission facilities are already available such that sources of supply at the

lower voltage may be provided not more than 10 to 15 miles apart, all of such territory may be more economically served at the lower voltage (4000). In this connection it is of course necessary to take all possible advantage of use of three phase transmission where load or distance warrants.

A system such as that mentioned under the third point having an average load density of 150-300 kw. per one thousand feet, would undoubtedly have load of sufficient importance to warrant greater continuity of service than could be given by a high voltage radial feeder, which to be economical must necessarily serve a large area. On the basis of the size of city blocks most frequently found in the area surrounding Chicago, the loads given above would involve densities on the order of 10,000 to 20,000 kw. per square mile. Standard secondary networks have been justified in many places where loads are much less dense. With the improvements in the design of network equipment and the development of the overhead protector, it would seem that this type of services should tend to be more economical for even less dense loads.

The tendency shown above of a higher voltage feeder only being justified for larger load densities is also confirmed by strictly theoretical studies of hypothetical cases which were made a few years ago. The results of these were presented at the meeting of the Power Systems Engineering Committee of the former N.E.L.A. in May, 1932. These involve a comparison of the relative costs for serving various load densities by the usual radial feeders at 2300 volts delta, 2300/-4000 volts "Y", and 4600 volts delta. They indicated that for load densities less than 175 kw. per square mile, the 2300 volt delta system is the most economical, that between that value and densities about 2800 per square mile, a 2300/4000 volt system was the most economical, and that above 2800, 4600 volt delta was slightly more economical than the 4000 volt. At a density of 5000 kw. per square mile, which was the highest considered in that study, the 4600 volt delta system was 8 per cent cheaper in total investment cost that the 4000 volt system. Obviously, a comparison with 6900 or 11,000 volts would show comparable results. These would indicate that the 6900 would not be more economical than the 4000 or 4600 for densities much less than approximately 10,000 kw. per square mile. This is largely due to the higher cost of transformers and lightning protective equipment.

Relative Cost Differences

It will be noted from the above discussion, that the relative difference in total cost of the distribution system for various voltages is usually small, especially for urban distribution. This indicates that in the final analysis the decision of the voltage to be used will generally be based quite largely on other factors which cannot be evaluated, such as the type of the previous system, present equipment which must be utilized, the type of service required, and other special conditions. The real advantage of making such studies lies more in showing the limits of design, the elimination of generalities, and the avoiding of "rule of thumb" methods which frequently lead to wrong conclusions, than in attempting to pick out the lowest cost system on the basis of strictly economic factors.

Other Factors Affected by Distribution Voltage

There are also a number of other factors which may be affected by the primary voltage and which must be given definite consideration before a final answer can be obtained. Among these may be listed the increase in transformer outages on the higher voltage feeders. This may be curtailed to some extent by the use of step-down banks to serve groups of transformers at a lower voltage. This practice is followed to a considerable extent on the system of the Public Service Company of Northern Illinois, and its use results in more economical distribution as well as the reduction of transformer troubles. The chief disadvantage of this arrangement is the increased voltage drop and added losses introduced in the system because of the step-down transformer. This, however, is largely offset by the elimination of trouble and increased facility with which lower voltage lines may be operated.

However, in many locations, particularly in rural territory where load is scattered, it is not practical to install such step-down transformers. Experience on the Public Service Company system indicates that in such instances transformer fuse outages are considerably higher than at similar localities where lower voltages are used. This is probably partly due to the lack of adequate clearances in the higher voltage transformers. With the increased trend toward the development of trouble free transformers there should be a reduction in both the relative cost of lightning protection at the higher voltages and also a reduction in the relative outages.

Other Phases of the Distribution Problem

1. *Transformer Loading.*

There is some tendency towards the operation of transformers at from 175 to 200 per cent of their rating at peak load for average residential service where the peak lasts for only two or three hours per day, and in many cases only one or two days per week. It will be interesting to have an analysis of the operating results obtained from this practise, both from the standpoint of the effect on the number of transformer failures and the effect on the tendency toward increased oil sludging. It has been claimed on some occasions that transformers of the usual compound impregnated type have a tendency to cause oil sludging when operated at on near their maximum temperatures.

2. *Losses.*

Additional study should be made of the matter of increased losses due to grounds, leakage, faults, etc. This is a subject about which there is little specific information available. The results of such a study will be of considerable value in distribution work, and should be made available when all information has been obtained.

3. *Cost of Lightning Protection.*

Lightning costs for higher voltage (6900) transformers may run as high as 200 per cent greater than those of 2300 volt transformers. As has been indicated it appears probable that this cost could be reduced and the efficiency of the protection increased if it were possible to take advantage of all knowledge of lightning protection which is at present available.

4. *Use of Parallel Secondaries.*

One of the chief disadvantages of providing increased secondary capacity by replacement of conductors is the cost of transferring services. This probably warrants more serious general consideration. The average of figures submitted by eighteen companies in connection with a questionnaire sent out to members of the former N.E.L.A. last year by the Distribution Design Subcommittee indicated, for example, that under given conditions the average labor cost of installing 3 No. 2 secondaries was $44.00 per 1000', whereas the cost of replacing No. 6 with No. 2 secondary was $79.70

per 1000′, an increase of almost 100 per cent. It is probable that the increased cost of replacing other sizes of secondary would be in proportion if conditions were similar.

This additional cost has been avoided in some cases on Public Service Company system by the installation of additional conductors in parallel with the present secondary conductors instead of replacing them with larger conductors. It is recognized that this method is not applicable in all cases and that it might not be desirable from a mechanical standpoint to use it as a standard practice. However, in many instances, especially where necessary to rebuild the system within a few years, it provides a method by which overloads may be temporarily relieved at a reasonable cost, and avoids both the expense and inconvenience to customers of transferring services.

Effect of Flicker on Distribution Design

1. *General.*

Because of the increase in the use of motor driven appliances, particularly the electric refrigerator, the effect of flicker due to motor starting currents upon both the primary and secondary distribution design is receiving increased attention. This ordinarily does not present serious difficulties in primary design unless flickers of especially high frequency are experienced. These are most usually caused by large single cylinder compressors or pumps and certain types of automatic welding equipment. In secondary design, however, the starting current of the average appliance motor must be given definite consideration. It is important in this work to distinguish between objectionable and noticeable flicker.

2. *Noticeable Flicker.*

There is rather general agreement that a voltage fluctuation of the order of 1½ to 2 volts which does not occur more frequently than 2 or 3 times per second will not be noticeable to the average individual.

3. *Objectionable Flicker.*

The limit of objectionable flicker, however, is, to a large extent, a matter of psychology, and involves so many personal and variable elements that it cannot be readily determined. We had one very good example which illustrates this point on the Public Service Company system. In one place where a recording voltmeter was set as a check on feeder regulation it was found that there was a very serious flicker condition due to several electric refrigerators being operated in the building from the same 2-wire service, and over a considerable length of secondary fed by a small size transformer. This created a flicker of approximately 20 volts, 10 or 15 times per hour. When the voltmeter was picked up the customer insisted that we remove it because the noise of the clock annoyed him very seriously. He mentioned that his service was entirely satisfactory, but that he didn't want any clock around.

In another instance a very serious complaint was made by a customer because of the very occasional flicker resulting from the operation of his electric range. In this case the flicker occurred only two or three times per hour, and then only during the period in which the range was operated, and its intensity was probably not over 3 or 4 volts. Because of this large psychological factor it is not practical to establish any definite standard of objectional flicker.

4. *Trend of Flicker to Decrease.*

It should also be recognized that flicker of this type will tend to decrease in intensity as the system capacity is increased. The most serious case of such flicker will usually be found on small isolated transformers such as those installed in rural territory or those in outlying sections of urban territory. As load increases larger transformers and secondaries will be utilized, and the effect of the flicker on any individual customer will be materially decreased.

5. *Recommended Design Basis.*

Because of these factors it would seem to us that except for those few cases where special flicker conditions are encountered such as extremely high frequency, or possibly extreme variations in voltage even at more modern frequencies, it is not practical to attempt to design a secondary distribution system which would be free from all objectionable flicker. The primary system, of course, probably should be designed to eliminate noticeable flicker. This ordinarily does not involve any extreme hardship.

6. *Additional Specific Information Valuable.*

In order to obtain more information on this point it would appear desirable to collect data on the types of flicker which actually cause complaints. Some work of this sort has been done on the Public Service Company system. It was found that out of 44 complaints analyzed, the majority of them were occasioned by flickers of the magnitude of 3-7 per cent at a frequency not exceeding 3 per hour. These values, however, were determined by the use of standard recording voltmeters, and are, therefore, subject to considerable error as far as the magnitude of the flicker is concerned. As the result of experience obtained on this kind of work it is our opinion that the magnitude of the flicker can only be reliably determined by the use of either an oscillograph or a preset needle voltmeter. With the use of the latter instrument it is of course necessary to take a number of readings to determine an accurate value. Satisfactory results in many cases could also probably be obtained by calculation if starting current and power factors are available.

Designs Which Tend to Minimize Flicker

1. *Use of Cable.*

There are several changes which can be made in distribution design to help improve flicker conditions. One of these, which has been used to some extent on the Public Service Company system, involves the use of an aerial cable secondary. The reduction in the reactive drop by the use of the cable makes a material decrease in the flicker voltage, particularly since a good many motor starting currents are at low power factors. This type of construction, however, is expensive, and usually can be only warranted in heavily loaded territory. Its chief application on the Public Service Company system has been at locations where combined light and power secondaries have been utilized, and where a 4-wire "Y" secondary system is used in anticipation of a future secondary network. It is probable, however, that if the service warrants, a somewhat simplified method of cable secondaries might be utilized by combining a number of single conductor, rubber covered wires on one messenger.

2. *Low Impedance Transformer.*

One of the most promising developments for the reduction of flicker is the use of a low impedance transformer. In numerous cases the drop through the standard transformer is of such a magnitude as to produce objectionable flicker, particularly where small units are concerned. The only method of correcting such a condition with the present transformers is to install surplus capacity

which is both expensive and unsatisfactory from the system standpoint.

Considerable study has been given to this problem by the Public Service Company. Designs were obtained from one manufacturer of a transformer having considerably lower impedances, and cost studies were developed to determine the economics of its use. These studies were based on both the 15 and 25 kv. sizes. A comparison of the characteristics of the proposed transformer with those of a standard transformer are given in the following table:

COMPARISON OF STANDARD AND PROPOSED DESIGNS OF 2300-115/230 VOLT TRANSFORMERS

	15 kv-a Standard	15 kv-a Proposed	25 kv-a Standard	25 kv-a Proposed
Impedance, per cent	2.86	1.2	3.11	1.15
Copper Loss	272.5	177	390	280
Core Loss	77.0	121	103	161
Total Loss	349.5	298	493	441
Regulation:				
100 per cent P. F.	1.84	1.18	1.60	1.12
90 per cent P. F.	2.61	1.19	2.59	1.14
80 per cent P. F.	2.81	1.05	2.89	1.08

It will be noticed that the impedance of the proposed transformer is less than half that of the standard, and that the total losses are less, but that the iron loss has been increased and the copper loss decreased. The comparison of the relative cost of using this new transformer was based upon a load equivalent to 2½ hours daily use of the maximum demand, and a cost of losses of ½c. per kwhr. The study showed an increase in total annual costs over a transformer of standard impedance of approximately 7.5 per cent at 100 per cent maximum load and an increase of approximately 4.45 per cent for a 150 per cent maximum load. Below are excerpts from the discussion of the results of this study:

"The greatest advantage, however, of the low impedance transformer is in the matter of voltage drop at low power factor loads as those occasioned by starting currents of some types of motors. At a power factor of 40 per cent the voltage drop in a low impedance transformer is less than ¼ of that in a standard transformer. In other words, to obtain the same results, four times as much capacity would be required for standard transformers as for low impedance transformers.

"The annual losses of the low impedance transformers are considerably greater than for transformers of standard design. When it is planned to load the transformers to merely 100 per cent of rating, the losses are about 32 per cent greater with the low impedance transformers while if it is planned to load the transformers to 150 per cent of rating the losses would be only 15 per cent greater for the low impedance transformer.

"In considering the question of losses, it should be remembered that the figures given above are based on what were considered typical lightning secondary load factors. In combined light and power installations in which the load factor is relatively high, it is quite possible for the losses to be less with the low impedance transformers. Also, as the load factor on lighting secondaries is improved through appliance sales the difference in losses in the two designs should become less.

"In view of the marked advantage of the suggested design of transformers with reference to voltage regulation and particularly so at low power factor loads, it is unquestionably superior to transformers of standard design for installations in which lighting flicker is a factor. Also, for installations in which lighting flicker is not a factor, it would appear that the slight increase in annual costs for the suggested design would be more than offset by the improvement in voltage regulation, and especially so in those cases in which loading on a heat basis is possible."

3. *Reallocation of Transformer Losses.*

In this connection it also appears that some study might well be given by the industry to the reallocation of transformer losses. No great change has been made in the division of losses for several years. Present conditions seem to warrant their reexamination. Present loads are different than those of the past, load factors in general are higher, copper losses should, therefore, be of relatively more importance than in the past, present energy losses are different, in general less, such that iron losses would tend to be of less consequence, also prices of copper and iron are materially different. All of these factors have a bearing on the proper allocation of transformer losses.

In addition to the advantages from the standpoint of reducing flicker, a low impedance transformer would tend to reduce transformer failure due to secondary shorts, since it would make it more nearly possible to fuse the smaller transformers to protect against such troubles. In the present transformers the impedances are so high that under short circuit conditions it is frequently not possible to pass enough primary current to operate the primary fuse.

SECOND ANNUAL CONVENTION

(Continued from page 146)

been sent to all members of the Institute. Reservations should be sent direct to hotel of first choice.

Transportation

The Passenger Associations have authorized on the Identification Certificate Plan, a reduced rate of a fare and a third for the round trip, from all points in the United States and Canada, with return limit of 30 days from date of sale. Only one Identification Certificate will be necessary for a delegate and dependent members of his family. To secure the reduced fare Identification Certificate must be presented and signed when purchasing round trip ticket to Atlantic City. Delegates should be prepared to identify themselves to the ticket agent. Routing, both ways, must be specified when purchasing tickets. The return route may differ from the going route. No change in routing will be allowed after the trip is started. Far Western delegates may find the summer tourist rates of advantage.

All railroad tickets must be validated before leaving Atlantic City by the ticket agent at the Registration Booth in the main lobby of the Hotel Traymore, or at regular ticket offices in Atlantic City.

Identification Certificates may be secured from the general office of the Institute, 420 Lexington Avenue, New York, N. Y.

It is suggested that Transportation and Hotel Reservations for the Convention be made promptly.

POWER STATION BUILDING COSTS

A Report of the Subcommittee on Power Station Buildings of the Power Generation Committee, Edison Electric Institute *

With the increase in capacity of steam generating units and the development of interconnection between stations and systems, together with the marked improvement in reliability of equipment, there has followed a definite trend toward simplification of layout to eliminate complicated interconnection of units and unnecessary duplication of auxiliaries.

This trend reflects the transfer of attention of designers from too sharp focussing on increased heat economy to the now more promising savings in reduced investment cost. To illustrate the significance of investment savings, the following table expresses a comparison between increases in initial cost equivalent to reductions in heat rate. In comparison with a 14,000 Btu/kwhr station costing $100 per kw of installed capacity operating at 40 per cent capacity use with $4 per ton coal and assuming 12½ per cent fixed charge rate, increased initial costs, to be justified, will require the indicated lower heat rates:

Cost/kw	$100	$101	$110	$120	$155
Heat Rate	14,000	13,750	11,500	9,000	0

This table shows that a 1 per cent increase in investment must result in approximately a 2 per cent reduction in heat rate in order to be justified under the given conditions.

When engineers and executives fully realize the cost of conventional plant superstructure and the significance of investment savings they will be less prone to accept without question of cost architect's plans primarily directed toward final finished pleasing appearance. They will rather apply the same searching analysis to simplifying structural design as has resulted in the great improvement in operating economy of the last decade and the simplification of equipment layout accomplished during the last few years.

It is the belief of this Committee that building costs can be reduced materially without too great sacrifice of pleasing appearance and none at all of fitness or adequacy for the real purpose of the plant.

Present Costs of Superstructure

A review of 15 power stations on which construction work dates from 1922 to 1933 shows an average of 14 per cent of the total plant cost chargeable to superstructure. A variation in this figure is noted among the plants of from 11 per cent to 18 per cent.

Selecting three of the more recently installed of these plants as representative of present day construction, it is found that exterior walls represent from 15 to 35 per cent of the total cost of superstructure. An average figure of 25 per cent would then imply that external walls accounted for something like 3 or 4 per cent of the total station cost. The steel frame represents another 25 per cent of superstructure cost. The remaining 50 per cent of the superstructure cost is accounted for by floors, roof, stairs, walkways, interior partitions, service equipment and miscellaneous expense.

In the cost of hydro-electric developments, normally greater per kilowatt than for steam plants, the building structure usually represents a very much smaller percentage of the total initial investment. In one recent installation the superstructure amounts to about 4 per cent of the total.

Outdoor Plants—Costs

Many look upon the outdoor plant as a way of saving 10 per cent or more of the total plant cost, assuming a saving nearly equal to the cost of superstructure of present plants. Those who have made a study of the problem realize that the savings, while such as to warrant careful consideration, cannot be expected to approach this value.

The Philadelphia Electric Company and the affiliated companies of The New York Edison System have given consideration to outdoor construction for large steam plants. These studies have determined in detail the relative cost of a completely outdoor type plant compared to similar equipment housed in inexpensive, factory type, medium grade common brick building. In the former case the cost difference is estimated at 1 per cent of the total station cost and in the latter approximately 3 per cent. Since the only sound justification for outdoor construction is reduced expense, it remains to be determined if such differences will outweigh the recognized disadvantages from the standpoint of operation and maintenance. No cost comparison with conventional construction is available.

The foregoing comparisons were made, it should be pointed out, with a type of building construction much less expensive than those quoted earlier in this report as typical. These studies indicate clearly that simplification of layout and architecture may be expected to accomplish practically as much reduction in cost as the outdoor station of extreme type.

A similar study of a water power development concluded that an existing housed plant could have been constructed only about ½ per cent cheaper had outdoor construction been undertaken. This figure is probably not representative of more favorable conditions existing at other locations.

Outdoor Plants—Construction and Operation

Two semi-outdoor fuel burning plants and several hydro-electric plants are now in operation under varied climatic conditions. The Schenectady installation of the General Electric Company has been constructed with no structure around the mercury turbine and only a closely fitting shell housing the boiler equipment. The auxiliaries are housed in a simple low structure which also provides office and service space. The exterior steel work of the building was designed to support all equipment and floor loads and then enclosed with pressed steel pilasters and facias to form a complete building exterior when filled in with metal sash construction. Interior partitions are also of light metal construction.

The Central Arizona plant, located near Phoenix, Arizona, where the climate is favorable to outdoor operation, is constructed with a housed turbine room, but the boiler room is open on the side facing the turbine enclosure and away from the direction of prevailing winds. The walls are built of expanded metal covered with four coats of gunite to a total thickness of one and one-half inches. The roof construction is corrugated metal decking with two layers of insulating lumber and a built-up felt roofing.

These two fuel burning plants, subject to widely divergent climatic conditions, have demonstrated the operating practicability of outdoor or semi-outdoor construction at least for the particular

(Continued on page 168)

*Members of the Subcommittee: F. S. Clark, Louis Elliott, Alfred Iddles, H. G. Roby, G. L. Knight, *Chairman*.

SURGE CURRENTS DISCHARGED BY ARRESTERS ON 24-KV OVERHEAD SYSTEM

During the last few years considerable data have been accumulated in regard to surge voltages that might appear on an overhead transmission system as a result of lightning discharges, but very little has been known concerning the currents that flow in a lightning stroke or must be discharged by a lightning arrester if it is to satisfactorily protect apparatus and service. In order to get some information on this subject, a practical surge current recorder was designed and installed in the common ground lead of the three-phase arrester assemblies used on the wood pole lines of The Detroit Edison Company system.

The recorder used is shown in Figures 1a, 1b and 1c, and consisted of a gap made up of two 2 in. diameter copper blocks separated by a 1.5 mil short fiber, cotton base, highly hydrated, waxed paper, such as is used for the dielectric in ordinary paper condensers. This paper is punctured when a discharge occurs. The gap is shunted by a 500-ohm resistor and the assembly mounted in a metal box about 4 in. by 4 in. by 6 in. dimensions, which is connected into the ground lead of the arresters. The resistance is used to shunt any charging current that is present and thus keep the grounded side of the arrester at ground potential.

During the development of this recorder a number of different combinations of gap material and dielectric were tried out and copper and paper were finally adopted because the results obtained were the most consistent of any of the materials tried. The final result is a device which gives a measurement of the maximum current, regardless of the duration of this current. The measurement is obtained by a determination of the size of the hole produced in the paper when it is punctured, due to a discharge through the arrester. Tests with a surge generator and also with 60 cycle current showed that there is relatively small difference in the size of the opening produced by a given peak value of current of a few microseconds duration or one of much longer duration, or several repetitions of this wave, or even with several cycles of 60 cycle current of the same crest value. The tests also indicated that if both small and large currents are impressed on the same paper, the indication obtained is that of the larger current only.

The size of the opening in the paper is determined by passing a given volume of air at a given pressure through the opening and measuring the time required for this air to pass through. The device used to check this time consists of two concentric cylinders about 30 in. long and 6 in. diameter, illustrated in Figures 2a and 2b. The larger cylinder is closed at the bottom end and is about half full of water. The smaller cylinder slips freely inside of the larger one and is closed at the upper end, except for a circular opening the same diameter as the discharge copper blocks of the recorders. The paper which has been punctured in the gap is placed over this opening and firmly clamped by a ring having the same size opening as the top of the cylinder, thus preventing any air leakage except through any openings produced in the portion of the paper between the copper blocks. The smaller top cylinder with the paper in place is placed inside the larger one with the open end of the smaller slightly below the water level. The upper cylinder is then released and the time required for it to drop a given distance is determined by a stop watch. In order to calibrate the device known values of surge current ranging from 50-amp to 100,000-amp were produced by a surge generator and were passed through one of the recorders, and from these discharges of known current values the corresponding time required for the cylinder to drop was determined and a calibration curve was obtained.

The recorders installed in the field were inspected after every storm and all punctured papers were brought into the laboratory and the surge current which produced the puncture was determined by timing them on this device. Obviously, the procedure does not give a true record of the total number of surges through any recorder, but only shows the maximum

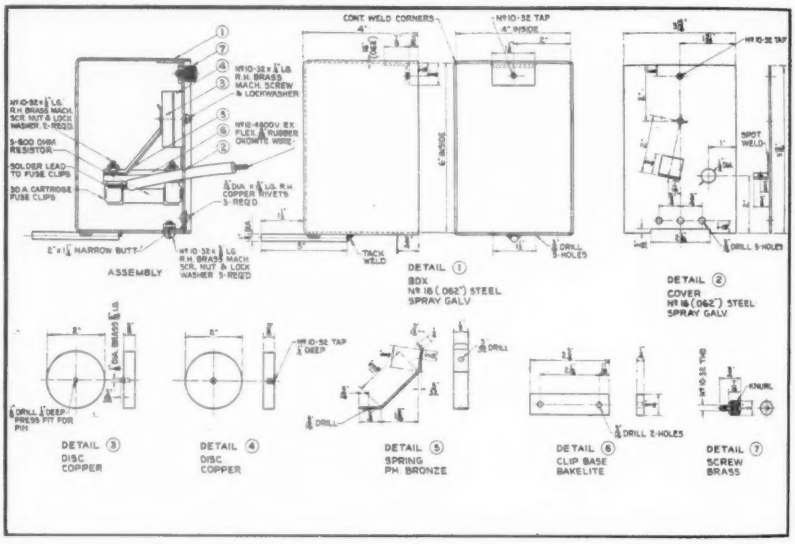

ASSEMBLY
DETAIL ① BOX Nº 16 (.062") STEEL SPRAY GALV
DETAIL ② COVER Nº 16 (.062") STEEL SPRAY GALV
DETAIL ③ DISC COPPER
DETAIL ④ DISC COPPER
DETAIL ⑤ SPRING PH. BRONZE
DETAIL ⑥ CLIP BASE BAKELITE
DETAIL ⑦ SCREW BRASS

Fig. 1a

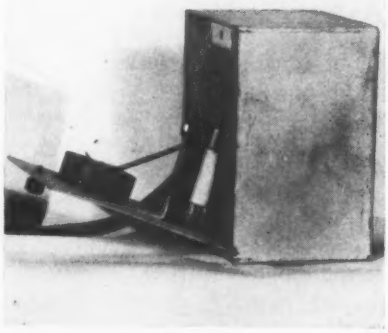


Fig. 1b

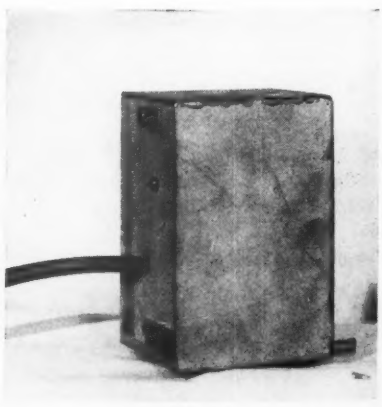


Fig. 1c

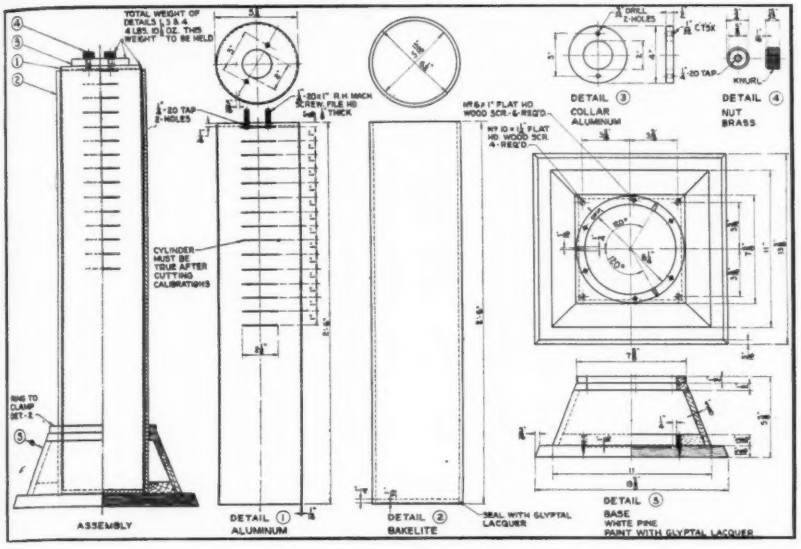

ASSEMBLY
DETAIL ① ALUMINUM
DETAIL ② BAKELITE
SEAL WITH GLYPTAL LACQUER
DETAIL ③ COLLAR ALUMINUM
DETAIL ④ NUT BRASS
DETAIL ⑤ BASE WHITE PINE PAINT WITH GLYPTAL LACQUER
CYLINDER MUST BE TRUE AFTER CUTTING CALIBRATIONS

Fig. 2a

discharge that has occurred between inspections. With the device installed in the common ground connection for a three-phase arrester set the record obtained is of the total current through all three units, but the distribution between phases is not known.

During the 1933 lightning season 499 records were obtained from the recorders installed and the magnitude of the currents were as follows:

	Current	*Number of Records*
0	500-amp	307
501	1,000 "	36
1,001	2,000 "	71
2,001	3,000 "	39
3,001	4,000 "	15
4,001	5,000 "	10
5,001	7,500 "	11
7,501	10,000 "	2
10,000	20,000 "	6
20,000	plus	2
		499

The actual value of the eight above 10,000-amp are 12,500; 12,500; 14,750; 17,000; 19,000; 20,000; 30,000; 34,000-amp.

From these records a curve showing percentage of the total records greater than a given current has been plotted (Figure No. 3).

The lines from which these records were obtained are all of wood pole construction, having a flashover at guyed poles of 450-kv impulse and several times this value for unguyed poles. The air break switches and cable potheads have impulse flashovers of about 150-kv.

In order to make any use of these data the complete impulse characteristics of all apparatus on any given system must be known, as well as the voltages that will appear across any given arrester at various values of discharge currents. These values were all obtained from tests made with a surge generator and it was found that the best so-called 80 per cent arresters can be expected to protect for currents up to 10,000 amp. The 80 per cent arrester is the type designed for use on a solidly grounded neutral system and has less voltage drop for a given current discharge than the 100 per cent arrester.

The curve of current values against per cent of total discharges for 1933, which was an average year, shows that about 1 per cent are above this value and should cause flashover if all the current

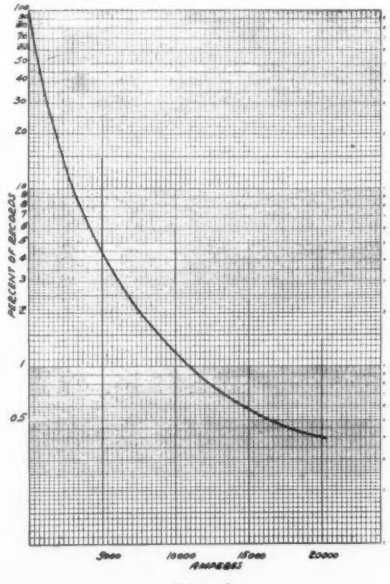


Fig. 3

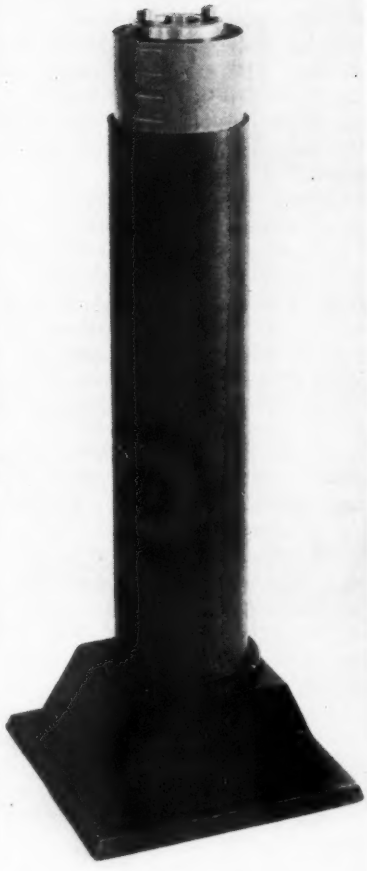


Fig. 2b

were through one unit only, which probably is not the case.

These data do not necessarily apply generally, but surge current records of this kind, obtained over several years operation, should give a fairly accurate picture as to what may be expected as to the average number of discharges for any given installation on the system, where the records had been obtained, and what percentage of these discharges will be above any given value of current. Knowing the characteristics of arresters and the flashover of the apparatus protected by these arresters, the engineer can predict with some degree of certainty the number of times any given piece of apparatus should be subjected to surge voltages greater than its flashover during its life, provided the particular installation is no more subject to lightning than the average of the territory over which records were obtained.

MEASURING RADIO NOISES

Joint Coordination Committee on Radio Reception—EEI—NEMA—RMA

The Joint Coordination Committee on Radio Reception through its subcommittee on Collection of Data has been receiving information on radio noise field intensities together with a limited amount of data on the relation of the noise field to satisfactory broadcast reception.

Included in the data received is a very interesting report covering a survey of radio noise conditions in a metropolitan area. A summary of this report is presented herewith under five captions: Noise Signal Ratio, Disturbing Field Strength, Means for Eliminating Noise, Effects of Antenna Characteristics and Influence of Radio Set Characteristics.

1. Noise-Signal Ratio

In this report noise observations have been classified as "severe," "objectionable," "tolerable" or "barely perceptible." Taking the average measured signal strength of the four stations under observation and the measured noise at 1000 kilocycles, noise signal ratios have been calculated for 33 cases. These are tabulated as follows:

	No. of Cases	Noise Signal Ratio		
		Maximum	Minimum	Average
Severe	10	600	0.4	—
Objectionable	9	0.5	0.1	0.29
Tolerable	7	0.1	0.005	0.037
Barely Perceptible	7	0.005	0.0005	0.0028

It will be observed that these general classifications correspond very satisfactorily to definite ratios of noise to signal. However, it should be noted that great care must be exercised in applying such ratios to specific cases because the character of the noise has a great deal to do with its effect as a disturber.

2. Disturbing Field Strength

Measurement of field strength in microvolts per meter at about 1000 kilocycles were made on the roof and near the customer's receiving set. The results of 27 measurements made on the roof show that in only 14 out of 27 cases was the noise field greater than 10 microvolts per meter and in only nine cases did it exceed 100 microvolts per meter.

In studying noise levels in the vicinity of the customer's receiver, it is most helpful to consider the ratio of noise field strength on the roof to that at the set. The data indicate that in 15 cases out of 26 the noise field strength near the set was greater than that on the roof; in five cases it was the same; and in six cases it was less. The unfavorable ratios, that is, those indicating greater noise near the set than on the roof were as large as 330.

3. Means for Eliminating Noise

Several means for eliminating noise are referred to in the detailed reports of individual cases. In general the methods are specific and involve repair of equipment, correction of faulty adjustment, or the installation of filters. In 11 cases the installation of filters completely eliminated the troublesome noise or at least reduced it to an acceptably low level. In connection with the installation of filters some of the experiences further emphasize the need for extremely short filter leads.

4. Effects of Antenna Characteristics

In 13 cases measurements were made of field strengths on the roof and of voltages developed in the consumers' antenna system. From this data calculations were made of "effective antenna heights" which were obtained by dividing the field strength (in microvolts per meter) observed on the roof, by the voltage (in microvolts) across a 600-ohm impedence connected in the consumers' antenna system. Observations were made on the signals from four broadcast stations and of noise at about 1000 kilocycles. Effective antenna heights in meters for station signal, obtained by this method, varied from 0.03 to 2.15 while those for noise varied from 0.4 to 50.

It should be noted that the term "effective antenna height" may be in some respects a misnomer because the values obtained are in fact a summation of many elements of which height is only one. The length of the antenna also enters in an important manner, as do the characteristics of the lead-in.

The calculated ratio of effective height for signal to effective height for noise gives an interesting measure of the susceptibility of the antenna system to disturbing noise fields. In only three cases out of 13 was the ratio greater than unity or favorables; while in 10 cases it was less and frequently as small as 0.01. It should be noted that these calculated ratios are influenced by a number of factors such as the directive characteristics of the antenna, the susceptibility of the lead-in, and the noise field distribution. Thus, an unfavorable ratio may be the combined result of a susceptible lead-in and a distribution of noise field which gives high intensities in the neighborhood of the lead-in.

From the meager data available no definite conclusions can be drawn as to the relative merits of different types of antenna systems but in general it appears that much of the noise enters the receiving system through the lead-in and that shielded or transmission line types of lead-ins offer distinct advantages. This might be anticipated from the general nature of the noise field and the source of the most usual noises. Where electrical utilization equipment is connected to the light and power wires, fields will be set up of such a nature that they will induce considerable voltage in the usual non-shielded vertical lead-in. Shielded or transmission line types of lead-in afford a considerable measure of immunity from such disturbances.

In considering this information, attention is called to the fact that the absolute values of effective height are subject to some question because the voltages used in computing them were measured across a 600-ohm impedance which is low compared with the usual input impedances of present-day broadcast receivers. However, this will not influence the calculated ratios previously described.

5. Influence of Radio Set Characteristics

Insufficient data are available to form a basis for conclusions as to the influence of radio set characteristics on susceptibility to noise. It appears, however, that antenna conditions predominate to such an extent at present that such set characteristics are relatively unimportant compared to antenna characteristics.

Additional Data Desired

The Joint Committee through its Sub-Committee on Collection of Data is desirous of securing other specific data on radio noise measurements from various parts of the country so that the local situations may be considered in

(Continued on page 168)

NOTES ON SALES COMMITTEE ACTIVITIES

(GEORGE E. WHITWELL, *Chairman*)

The residential sales subcommittee under D. M. DeBard, Stone & Webster Service Corp., chairman, has been studying the status of service classifications in the home. Summarized statements and reports issued by subcommittees appointed to investigate follow:

Rentals or Trial Plans

A recent survey of electric range and water heater "rentals" or "trial" plans, prepared by a subcommittee under L. R. Parker, Commonwealth and Southern Corp., chairman, reveal that the methods used and results obtained show a wide divergence; some companies have been quite successful in their operations, while others show only mediocre results. However, in those companies where it appears from the tabulation that success has not been registered, "renting" or "trial" plans cannot be criticized, because, although quite complete, this tabulation is not an entirely comprehensive picture. The manner of presentation to the public; that is, as a "straight rental" or as an adjunct to sales; the public's knowledge of electric cookery and other features are factors that have marked bearing on results to be obtained through this method. In a number of the companies where the rentals were not eminently successful in themselves, it is stated that the rental plan has had considerable bearing on sales, in that the utility's willingness to rent equipment has been an assurance to the prospective customer that electric cookery is satisfactory.

Promotion and Sale of Small Appliances

In a comprehensive report on the promotion and sale of small appliances, A. Monty, Philadelphia Electric Company, chairman of the small appliance subcommittee, states that in a territory of 100,000 meters, estimates show that there is a potential market of approximately $5,000,000 from small appliances, with an estimated annual consumption of approximately 32,000,000 kilowatt-hours.

The value of the small appliance load to the utility is important enough to be considered a major problem. A national program which is developed to help overcome the problems involved in the sale and promotion of small appliances cannot fail to be of great value to all concerned.

Financing of low-priced items, so essential for satisfactory sales volume, still needs attention.

Commercial finance companies are not interested in financing small sales. It, therefore, becomes the task of the utility to provide some means for developing this business and making financing facilities available for the small dealer. In no other way can proper dealer relations be maintained and a substantial volume of small appliances be sold to the low-consumption group of consumers.

The committee has investigated a number of dealer and utility financing plans, but insofar as commercial finance companies are concerned, very little information has been obtained on the subject of utility financing, and representatives seem reluctant to supply any specific information.

The Domestic Laundry Load

B. H. Gardner, Columbia Engineering Corp., chairman of the subcommittee on home laundry, submits information on the domestic laundry load:

For a number of years the utility industry was gradually losing the domestic laundry load. During the prosperous years just preceding the beginning of 1930 there was a tremendous growth in the commercial laundry business. A greater and greater number of families sent their laundry work away from home. Since the beginning of 1930 there has been a reversal of this process. Under the necessity or desire of decreasing family expenditures, a continually larger percentage of homes are taking care of their own laundry work. This trend is of considerable importance to the utility industry, for it means increased sales of utility service. The best information available seems to indicate that approximately 200 kwhr per year is used in the average home by the electric washer and ironer and by the incidental additional lighting. In other words, this is the added load that may be expected when the laundry work is brought back into the fully modern home laundry. Most of this is added load, because the majority of commercial laundries do not use utility service to any great extent. When it is borne in mind that the sales per domestic customer for the entire country averages about 600 kwhr per year, then it can be seen that the home laundry load (with 200 kwhr per year) is about one-third of the present average residential sales. Surely this load is of sufficient volume and value to merit real study and attention. From the standpoint of the customer, the purchase of electric service for laundry work in the home represents a real bargain. If we assume that the rate for this incremental laundry use will average not over five cents per kwhr and that this load will amount to 200 kwhr per year, then it can be seen that the total cost to the customer will be $10 per year, or approximately 20 cents per week. Surely any service that will perform such difficult work at such low cost must be considered a real bargain. On the other hand, additional revenue of $10 per year from existing residential customers will be very welcome to any utility company.

During the past few years there has been a tendency on the part of many utility companies to eliminate the sale of electric washers. This appliance has such general customer acceptance and there are now so many well qualified dealers handling washers that some utilities feel they can eliminate their own direct sales. It would seem that those utilities that are still actively merchandising washers should only sell them at prices at least as high as prices maintained by competing dealers on washers of similar quality. In this way independent dealers will be encouraged to put forth increased effort on the sale of laundry equipment and the utility will be enabled to realize some profit on its own sales. Where the utility does not engage in the direct sale of washers, it would seem that the laundry load is of sufficient importance so that the utility would be justified in giving encouragement to the dealers who do sell such equipment, and should help in promotional work in any way that seems reasonable.

When we come to consider the electric ironer, the situation is quite different, for this device has not yet achieved the customer acceptance that results in a large sales volume. *Electrical Merchandising* estimates that electric ironers have attained a saturation of only 4 per cent, as compared to 42 per cent for washers; and that during 1933 sale of ironers totaled only 65,000 units, as compared to about 1,000,000 washers. It can therefore be seen that there is a

real job of promotion to be done in connection with the ironer, and every utility should consider ways in which it can best promote the acceptance and sale of ironers. In this connection, however, it must be remembered that, in most cases, the energy consumed by an ironer does not represent new load, since the ironer usually replaces the ordinary electrically operated hand iron, and it must be remembered that the electric iron is the most generally used of all electric devices, having reached a saturation of better than 95 per cent. However, the electric ironer does save much time and labor for the housewife, and therefore deserves to be actively promoted by the utility.

Where the utility represents a combination property, the laundry load has an additional attraction, since gas service will be needed in connection with hot water, boiling operations, etc. Combination companies should not overlook this possibility of increased gas sales that will result from the promotion of electric laundry equipment.

Activity of Subcommittee on Industrial Power and Heating

W. H. Sammis, The Commonwealth & Southern Corp., chairman of the subcommittee on industrial power and heating, has submitted a brief summary of its activities since the 1933 convention:

Industrial Heating

Items of interest on small unit industrial installations have been prepared for publication each month in the EDISON ELECTRIC INSTITUTE BULLETIN. The committee has urged all member companies, by letter, to adopt a direct-by-mail campaign and has called their attention to the material being offered by the manufacturers.

Information and data is being collected on the subject of gray iron melting, with the thought of disseminating this data to the industry in the form of a serial report. This report will not be completed this fiscal year.

Under date of July 20 a memorandum covering discussions at the meeting of the power committee representing the American Foundrymen's Association, the Steel Founders' Society of America, the Malleable Iron Research Institute and the Gray Iron Institute was sent to all members of the Sales Committee, together with copy of a letter from Mr. Wallis, chairman of the committee representing these associations, to Mr. E. W. Lloyd relative to the possibility of holding a joint meeting with representatives of the Edison Electric Institute. A meeting of these representatives was held under date of Nov. 14 at Edison Electric Institute headquarters. These associations were represented by: W. B. Wallis, Pittsburgh Electric Furnace Company; R. D. Brizzolara, American Steel Foundries; George Thompson, Continental Roll & Foundry Company; A. G. Hageboeck, Frank Foundries Company; J. R. Allan, International Harvester Company.

The representatives of these various associations are primarily interested in the standardization of the form of rate structures.

The question of cooperation between the local industry and the local utility was emphasized, with the thought that the various associations and the Institute could promote such cooperation among their members.

Commercial Cooking

A serial report on "Marketing Electricity for Commercial Kitchens" is in preparation. It is planned to make this a condensed report and expand on the various items in the EDISON ELECTRIC INSTITUTE BULLETIN from month to month.

Bibliography of articles on commercial cooking covering the last ten years was published in the February issue of EDISON ELECTRIC INSTITUTE BULLETIN.

Material is practically prepared for a series of articles on various installations, including testimonials from users. This material will be published in various trade papers that reach the customers.

Contacts are being maintained with trade associations, particularly the American Restaurant Association, the Hotel Association and the Hospital Association.

Educational Literature for Junior Power Pumping, etc.

Under date of March 10 a report was sent to all members of the sales committee on the annual meeting of the Petroleum Electric Power Club, incorporating information on the standardized rate and contract forms used so successfully in obtaining 7700 kw from the Great Lakes Pipe Line Company in electrifying their line from Oklahoma to Iowa, Illinois and Minnesota.

The February issue of the EDISON ELECTRIC INSTITUTE BULLETIN carried a supplement to N.E.L.A. report No. 25, on "Electric Service for Oil and Gasoline Pipe Line Pumping." Reprints have been sent to all member companies.

Efforts will be made to prepare information and data on use of electricity for production.

The subcommittee is cooperating with the Mid Continent Petroleum Section of the A.S.M.E., the American Petroleum Institute and the Petroleum Electric Power Club in connection with the various activities.

Hotel and Office Building Competition

A serial report on hotel and office building competition is in preparation, supplementing publication No. 112 issued by the N.E.L.A. in January, 1931, on this subject. It is anticipated that this report will be completed by the end of the fiscal year.

Power Sales Items

Power sales items which should be of interest to member companies are prepared each month for publication in the EDISON ELECTRIC INSTITUTE BULLETIN.

Educational Literature for Junior Power Sales Engineers

It is thought that information on various industry processes should be of immense assistance in the training of junior power sales engineers. The subcommittee has prepared some material; it has found that manufacturers have available similar material, and an effort will be made to consolidate this information and distribute it to the industry before the end of the fiscal year.

Rural Sales Subcommittee

The rural sales subcommittee of the Sales Committee has sensed the demand for coordinated and intensive selling of specific services in rural communities along similar lines to the lighting, table cookery and refrigeration programs. An outstanding need in many thousands of rural and semi-rural homes is running water.

With the thought in mind that something might be done about it, Chairman P. H. Powers appointed a special committee to confer with the National Association of Domestic & Farm Pumping Equipment & Allied Products Manufacturers. That association has expressed a sympathetic interest in some form of program and a special committee has been appointed from its water systems section to work jointly with Edison Electric Institute toward the development of a plan of promotional action.

This committee of pump manufac-

(Continued on page 168)

REFRIGERATOR SALES TOTALLING 269,319 UNITS SET NEW FIRST-QUARTER RECORD

Unprecedented March Gain Lifts Three-Months Total Nearly 100,000 Above Best Previous Mark—All But Five States Ahead of Quotas

Sales of household electric refrigerators in the United States in the first quarter of this year, as reported by the Electric Refrigeration Bureau, set a new all-time record for the period with a total of 269,319 units. This total exceeds by 139 per cent the total sales in the first quarter of 1933, when 112,643 units were sold, and compares with the previous first-quarter record of 170,793 sold in 1931.

March unit sales reached a total of 151,668, compared with 82,439 sold in February, 58,494 in March, 1933, and the previous March record of 94,778, made in 1931.

Discounting the fact that last year's March sales were affected adversely by the bank holiday, nevertheless the fact that the previous March high was topped by such a wide margin, together with the amazing first-quarter total, exceeding the previous record for the period by 100,000 units, leads the bureau to believe that a new all-time year's record is in the making.

The first-quarter sales figures represent 133.2 per cent of the bureau's quota for the period and are based upon actual sales reported by 16 of the manufacturers in the NEMA group.

All but five States equalled their individual quotas for the period and the percentages of realization for those which topped 100 per cent ran all the way from 107.9, scored by Rhode Island, to 204.8 by Alabama. Others noted among the first-quarter leaders are Oregon, Oklahoma, West Virginia, Kansas, Texas, Tennessee, Missouri and Georgia, all of which scored more than 190 per cent.

Among the regional divisions, the southeastern, under the supervision of Regional Director J. G. Holtzclaw and comprising the States of Alabama, Florida, Georgia, North and South Carolina, Tennessee and Virginia, continued to lead the entire country with a percentage of 178.5. The southwestern division, Arkansas, Louisiana, Mississippi, Oklahoma and Texas, under the direction of J. F. Owens, was in second place with 177.6 per cent, while C. F. Farley's middle west division, consisting of

ELECTRIC REFRIGERATION BUREAU
SALES—HOUSEHOLD MODELS ONLY—THREE MONTHS 1934

	YEAR'S QUOTA	THREE MONTHS' QUOTA—20%	ESTIMATED TOTAL SALES	% QUOTA REALIZATION
New England Division				
Connecticut	19,243	3,848	3,469	90.1
Maine	7,899	1,580	1,373	86.8
Massachusetts	49,224	9,845	11,958	121.4
New Hampshire	5,095	1,019	767	75.2
Rhode Island	8,074	1,615	1,743	107.9
Vermont	3,305	661	420	63.5
Eastern Division				
Delaware	2,054	411	695	169.0
Maryland & D. C.	20,319	4,064	7,596	186.9
New Jersey	49,202	9,840	11,393	115.7
New York	154,788	30,958	36,629	118.3
Pennsylvania	86,678	17,336	25,142	145.0
East Central Division				
Kentucky	11,293	2,258	3,655	161.8
Ohio	64,710	12,942	17,988	138.9
West Virginia	7,970	1,594	3,171	198.9
Middle West Division				
Iowa	19,012	3,802	4,914	129.2
Kansas	14,127	2,825	5,579	197.4
Missouri	27,824	5,565	10,828	194.5
Nebraska	9,783	1,956	2,894	147.9
Pacific Coast Division				
Arizona	2,916	583	934	160.2
California	78,695	15,739	16,757	106.4
Nevada	714	143	236	165.0
North West Division				
Idaho	3,303	661	1,071	162.0
Montana	3,550	710	885	124.6
Oregon	10,010	2,002	3,989	199.2
Utah	4,863	973	1,473	151.3
Washington	18,025	3,605	4,039	112.0
South Eastern Division				
Alabama	7,187	1,437	2,944	204.8
Florida	9,790	1,958	2,327	118.8
Georgia	8,309	1,662	3,218	193.6
North Carolina	10,945	2,189	4,129	188.6
South Carolina	4,358	872	1,645	188.6
Tennessee	9,783	1,957	3,849	196.6
Virginia	11,031	2,206	3,776	171.1
Great Lakes Division				
Illinois	77,150	15,430	16,703	108.2
Indiana	28,271	5,654	7,311	129.3
Michigan	44,387	8,877	9,888	111.3
Wisconsin	26,180	5,236	6,130	117.0
North Central Division				
Minnesota	19,794	3,959	3,747	94.6
North Dakota	2,511	502	619	123.3
South Dakota	3,217	643	1,021	158.7
Rocky Mountain Division				
Colorado	8,420	1,684	2,309	137.1
New Mexico	1,388	278	500	179.8
Wyoming	1,311	262	491	187.4
Southwestern Division				
Arkansas	4,554	911	1,692	185.7
Louisiana	8,242	1,648	1,788	108.4
Mississippi	3,568	714	818	114.5
Oklahoma	10,531	2,106	4,190	198.9
Texas	26,903	5,381	10,626	197.4
Totals	1,010,506	202,101	269,319	133.2

Iowa, Kansas, Missouri and Nebraska, jumped to third with 177.4 per cent.

March sales in a number of States showed astonishing increases over the same month last year. For instance, more than five times as many were sold in West Virginia as in March, 1933. Tennessee and Ohio quadrupled last March's record. In Massachusetts, Maryland and Kentucky nearly three times as many were sold, and Texas, Pennsylvania, Alabama, New York, California and Missouri more than doubled their sales of March a year ago.

Shows Attract Large Attendance and Interest

Reports on spring electric refrigeration shows continue to pour into the New York office of the bureau from all parts of the country, indicating a record participation in this form of activity. Moreover, there seems to have been no abatement of interest on the part of the public in those towns where shows have been held in previous years, as witness, for instance, the sixth annual Philadelphia show which was attended by 36,000 people and where sales in the record amount of $65,000 were made.

The third annual Lincoln, Neb., show had a record attendance and, among the headliners, the Pittsburgh, Buffalo and Camden exhibits held to the level of former years in attendance and public interest.

A partial list of other cities where all-refrigeration shows have already been held follows:

Louisville, Ky.; Covington, Ky.; Chester, Pa.; Bowling Green, Ky.; Toledo, Ohio; Fall River, Mass.; Batavia, N. Y.; Laramie, Wyo.; Allentown, Pa.; Lancaster, Pa.; Vincennes, Ind.; Kenton, Ohio; Mt. Vernon, Ohio; Guthrie, Okla.; Canton, Ohio; Parkersburg, W. Va.; Elizabeth, N. J.; Plainfield, N. J.; Evansville, Ind.; Hamilton, Ohio; Lancaster, Ohio; Marion, Ind.; Alexandria, Ind.; Fresno, Cal.; San Diego, Cal.; Utica, N. Y.; South Bend, Ind.; Galveston, Tex.; Oklahoma City, Okla.; Bedford, Ind.; Flint, Mich.; Hartford City, Ind.; North Tonawanda, N. Y.; Fostoria, Ohio; Burlington, Iowa; Trenton, N. J.; Vineland, N. J.; Rockford, Ill.; Portsmouth, Ohio; Pottsville, Pa.

Cities which have held electrical shows in which refrigeration shared the exhibition space with other appliances include Kansas City, Mo.; Omaha, Neb.; Cincinnati, Ohio; Clarksburg, W. Va.; Wilmington, Del.; Terre Haute, Ind.; Hoboken, N. J.; Jersey City, N. J.; Boise, Idaho; Billings, Mont.; Passaic, N. J.; Paterson, N. J.; Elkhart, Ind.; Stroudsburg, Pa.; Tiffin, Ohio.

Allison Completes Record Speaking Tour

Field Manager Allison returned to New York on Friday, May 4, from a nine weeks' trip, in the course of which he addressed nearly fifty meetings. Very much larger average attendances than on any previous speaking tour under bureau auspices, more optimism and vigorous sales action among distributors and dealers everywhere makes Dr. Allison confident that 1934 will prove to be electric refrigeration's banner year.

Nearly 13,000 miles by rail, bus and automobile were traversed by the field manager on this trip, and a total of 9,676 people attended the meetings which he addressed.

RADIO NOISES

(Continued from page 164)

the analyses of noise levels and their relation to the quality of reception obtainable. More data are also desired on the methods and results of mitigative measures. In order that the data so obtained shall be consistent, it is essential that the radio sets used have similar fidelity characteristics and similar band widths of frequency response. To this end the Joint Committee through its Subcommittee on Instrument and Methods of Measurement has prepared and issued complete specifications for a radio noise measuring set together with recommended methods of measurement.

Companies having available the proper equipment are urged to cooperate with the Joint Committee by submitting data either to C. S. Young, chairman of Sub-Committee on Collection of Data, c/o Pennsylvania Power & Light Company, Allentown, Pa., or to Edison Electric Institute, 420 Lexington Avenue, New York City.

BUILDING COSTS

(Continued from page 161)

circumstances surrounding these installations.

Both plants have employed unconventional building materials inherently cheaper than brick construction and in addition reduced the volume of building to a practical minimum.

Twelve outdoor hydro-electric plants have been in operation, representing approxmately 125 plant-years, in all varieties of climate. It is felt that the record of this type of station, in all parts of the country, is such as to prove practicability from an operating standpoint.

Conclusion

There is an acknowledged trend toward reduction of initial cost of power stations through simplification of layout and reduction of building cost. The method accomplishing the reduction varies with each individual case. Existing examples, although few in number, offer material worthy of careful study prior to construction of future plants.

To effect real reductions in initial plant cost will require executive approval of designs which depart from established convention and close cooperation between engineer and architect to achieve minimum building primarily constructed to afford shelter to power generating equipment and operators and yet avoiding unpleasant appearance.

SALES COMMITTEE

(Continued from page 166)

turers consists of C. W. Coapman, Delco Appliance Corporation, Rochester, N. Y., chairman; W. H. Wallbaum, Fairbanks, Morse Company, Chicago, Ill.; J. C. Myers, F. E. Myers & Brother Company, Ashland, Ohio; N. J. Gould, Gould Pump, Inc., Seneca Falls, N. Y.; H. C. Angster, National Association Domestic & Farm Pumping Equipment & Allied Products Manufacturers, Chicago, Ill., and A. E. Hazeldine, Red Jacket Manufacturing Company, Davenport, Iowa.

A special committee representing Edison Electric Institute includes P. H. Powers, chairman; Dr. E. A. White, director of Committee on Relation of Electricity to Agriculture, Chicago; F. A. Belden, Edison Electric Illuminating Company, Boston, and C. E. Greenwood, Edison Electric Institute, New York City.

A meeting of these groups was held on April 25. Mr. Powers was elected chairman of the joint committee which will carry the title Electric Water Systems Council; Mr. Coapman, vice-chairman, and Mr. Angster, secretary. The committee has in mind a program extending over fifteen months starting Aug. 1, 1934, with concentration periods of coordinated effort nationally, and cooperative selling locally. The objective of the council will be to double the rate of sale of electric water systems and establish a better working relationship between the utilities and dealers in electric pumping equipment.

A plan of activity is now under advisement, details to be announced on or before the first of June.

DECISION OF MASSACHUSETTS COMMISSION IN DISMISSING PETITION FOR RATE REVISION

On April 2, 1934, the Massachusetts Department of Public Utilities handed down a decision dismissing petitions of Selectmen of Saugus, Mass., and Selectmen of Marblehead, Mass., asking revision of rates charged by the Lynn Gas & Electric Company. The full text of the decision is given herewith.

(D.P.U. 4576)

Petition of Selectmen of the Town of Saugus (Mass.) for a reduction in the price charged for gas and for electricity sold and delivered by the Lynn Gas & Electric Co. in said town.

(D.P.U. 4668)

Petition of Selectmen of the Town of Marblehead (Mass.) for a reduction in the rates charged for gas by the Lynn Gas & Electric Co. in the town of Marblehead and complaining that said company refuses and neglects to supply electricity in bulk at reasonable rates to the Marblehead Municipal Lighting Plant and requesting a reduction in the price charged for such electricity sold in bulk.

These two complaints were heard together. Saugus is within the area in which the Lynn Gas & Electric Co. supplies both gas and electricity. In Marblehead the Lynn Gas & Electric Co. distributes and sells gas but not electricity.

In 1927, by reason of the inadequacy of the municipal lighting plant of the town of Marblehead, the Municipal Light Board of that town entered into arrangements with the Lynn Gas & Electric Co. for the purchase of such quantities of electric current as the Board might desire for a period of five years. On June 1, 1932, a second contract was entered into by which the Lynn company was bound to supply the town with its requirements, at the price of 1.85c per kwhr at the Swampscott substation, subject to a coal clause, that for each 25c increase or decrease in the price of coal per gross ton delivered into the bunkers of the Lynn Company from the assumed base price of $5.35 per ton, the price of current should be increased or decreased 2 mills per kwhr. At the suggestion of the Municipal Board a stipulation was also included in the contract whereby the Board agrees that it will operate its municipal generating station for not more than 10 hours daily. Under the arrangement the Lynn company transmitted the electricity from the substation to the Swampscott-Marblehead line.

The petition of the Selectmen of Saugus requests a reduction in both the price of gas and electricity, and the petition of the Selectmen of Marblehead requests a reduction in the price of gas distributed and sold in Marblehead and a reduction in the price of electricity sold under the arrangement between the Lynn Company and the Municipal Light Board.

The total plant investment of the company at the end of 1932 amounted to $15,169,155. The net earnings of the company for the year 1932 were $991,417.30. The appropriations to its reserves for depreciation during the year 1932 on acccount of its gas plant were $79,994.38, and on account of its electric plant, $260,254.47! These appropriations, in our judgment, were not excessive. The company has a very unusual capital structure. The par value of its capital stock is $4,095,000, whereas there has been paid in as premiums on this capital stock $6,149,731.25, making a total of $10,244,731.25 that has been paid into the treasury of the company for the purchase of stock. The earnings represent, upon this amount paid into the treasury of the corporation by the stockholders, 9.68 per cent. The company has depreciation reserves of $2,838,813.09 and a corporate surplus of $3,426,158.86. The net earnings for the year 1932 represent 8.04 per cent on the total plant investment, less the company's reserve for depreciation.

At the hearings no evidence was introduced by anyone to support a reduction in the rates applicable to gas.

It was argued by the petitioners in the Saugus case that household rates should be changed by reducing the present rate for the first 25 kwhr to 6c per kwhr, or reducing the first step in the rate from 25 kwhr at 6½c to 15 kwhr at 6½c, thus making the rate 6½c for the first 15 kwhr, 5c for the next 75 kwhr and the balance at 3c, in place of the present rate of 6½c for the first 25 kwhr, 5c for the next 75 kwhr and 3c for the balance. One would mean a reduction to all domestic customers of 12½c a month; the other 15c a month. The first suggestion would affect a reduction in the company's revenues of approximately $52,000 a year, while the second would reduce the revenues approximately $63,000 a year. If times were normal either of these changes might well be adopted without serious result to the company. However, times are not normal and we feel that we ought not to order a reduction in existing rates without serious consideration, unless it appears that a company is earning an excessive return upon the capital employed in the enterprise, or for some other sound reason. A saving to the consumer of 15c a month or 12½c a month ought not to be overlooked, if it can be accomplished in the public interest and with justice to the company.

This company strikingly illustrates the fact that the per cent of dividends paid on the capital stock offers no criterion of their reasonableness. While it paid dividends in the year 1932 of 24 per cent upon the par value of its stock, these dividends amounted to 9.59 per cent on the money actually paid into the treasury of the company by its stockholders. Moreover, this 9.59 per cent is not based in any way upon its surplus of $3,426,158.86 which is entitled to some consideration in determining a reasonable return, as pointed out in our decision in the Northampton Electric Lighting Company case, made January 18, 1933. The money that has been paid into the treasury of the company by its stockholders, plus this surplus, amounted to $13,670,890.11 at the end of 1932. The dividends paid by the company during 1932 amount to 7.19 per cent upon this amount.

It is urged by the petitioners "that the basis for fixing rates in Massachusetts, under reasonably ordinary conditions, is the money honestly and prudently invested by the stockholders; and that that does not, in the case of this company, exceed the sum of par plus premiums." We agree with the petitioners that it has been the practice in Massachusetts, under ordinary circumstances, to base the return that should be allowed a pub-

lic utility upon the money honestly and prudently invested by the stockholders if there has been no impairment in the capital. This, we think, has been the policy of Massachusetts since the creation of turnpike companies. Mr Justice Brandeis, with whom Mr Justice Holmes concurred, expresses this same thought in dissenting from the opinion of the Supreme Court in the case of *Southwestern Bell Telephone Co.* v *Public Service Commission of Missouri, et al,* 262 U.S. 276, where he says it is the "capital embarked in the enterprise" upon which the utility is entitled to the opportunity of earning a fair return. Some consideration, however, we believe must be given to surplus where the company, by wise foresight and sound and efficient management, has accumulated, as here, a large surplus, for the reasons set forth at length in our decision rendered in the fixing of rates of the Northampton Electric Lighting Co., referred to above.

While the Department has never subscribed to the construction given to the Fourteenth Amendment by the Supreme Court of the United States, as affecting the regulation of rates of public utilities, and the theories and practices resulting therefrom, believing that the regulation of rates is an economic problem rather than a legal one, nevertheless some consideration must be given to the decisions of that court where the question of rates is involved. We think it plain that the earnings of the Lynn company as a whole are less than what a Federal Court would find it was entitled to earn under the Federal Constitution upon the value of its property as found under federal theories. We base this opinion upon the experience of the Department in the case of the Worcester Electric Light Co. which was decided in 1927. There the capital stock was $2,400,000, the premiums $1,658,232, and the surplus $1,536,175, making a total of stock, premiums and surplus of $5,594,407. It is true it was contended that the surplus should be increased by $3,000,000 for the reason that the amount of depreciation charged off by the company prior to 1921 was $3,000,000 in excess of property retired. Nevertheless, if we assume that the surplus of the Worcester Company in 1927 was in reality $4,536,175, and this the total of the stock, premiums and surplus was $8,594,407, it compares with the present stock, premiums and surplus total of the Lynn Company of $13,670,890. Upon resort to the Federal Court by the Worcester Electric Co. the Master appointed by that court found the fair value of the company's property for rate making purposes to be $15,295,000. If, in applying the principles that have been enunciated by the Supreme Court in determining the fair value of a public utility for rate making purposes, if the value of the Lynn Company's property should result in a figure in excess of of the stock, premiums and surplus proportionate to be found in the Worcester case, it would amount to approximately $24,000,000.

Assuming that the Worcester Company's plant investment of $6,605,450 as it stood on its books at the end of the year 1926 should have been increased by $3,000,000, as claimed by the company, its plant investment then was $9,605,450. The Lynn Company's plant investment at that time was $9,438,672. If the fair value of its property for rate making purposes under the Federal theory was in excess of its plant investment in the proportion that it was found the Worcester Company's exceeded its plant investment, which seems probable, then the Lynn Company's property on December 31, 1926, was of the value of $15,019,759 for rate making purposes. Adding to this the actual increase in the company's plant investment between December 31, 1926 and December 31, 1932, $5,730,483, gives a total of $20,750,252. To this there should be added certain intangible values allowed under the Federal theory which are not included in plant investment as established under our system of accounting. Some slight allowance must be made in the above figures, due to the fact that the value of the Worcester Company's property was found by the Master as of July 1, 1927, and as there was added to that company's plant investment $397,142.57 during the year, some portion thereof was probably added prior to July 1. Shrinkage in value that has taken place since 1927 would be largely offset by the revaluation of the dollar, one of the objects of which is to restore values approximately to those of 1926. Viewed, therefore, from the standpoint of the Federal courts, it is not at all unlikely that the return of the Lynn Company in the year 1932 would be found by a Master to be not much more than 4 per cent upon the fair value of the property for rate making purposes, notwithstanding it represented 24 per cent upon the par value of its capital stock.

It is interesting to compare the results obtained by the public from the Lynn Company with those that would have been obtained if it had been operated through public ownership in the year 1932. Assuming that the public would have reproduced the property, or property capable of furnishing the same service for $15,169,155, the amount of its plant investment, which in view of the finding of the Master in the Worcester case seems unlikely, and could have borrowed the money necessary to make the purchase on bonds at 4 per cent, the cost to the public would have been $606,766.20 for interest charges. On the other hand, the company paid in taxes, in the year 1932, $679,629, which the public would lose if the property were public operated. This added to the annual interest charges would make a total of $1,286,395.20, the actual cost to the public, whereas the net earnings under the operation of the company during the year 1932 were $991,417.30, which may be said to represent the cost of the capital employed in the undertaking. Thus the result to the public, assuming equal efficiency in operation and equal provision for depreciation, would have been a loss of approximately $295,000.

It appeared at the hearing that the kilowatt-hours sold in 1932 on the household and commercial rates were 23,583,475. Thus the price on these rates could have been reduced by 2c per kwhr, at a cost to the company of $471,669. The domestic and commercial rates, therefore, if the company had been free of taxes, could have been reduced 2c on each step and have left $207,960 to have been applied to other rates, without reducing the dividend payment or appropriation to depreciation reserve. By this reduction of 2c a kwhr the rate for household purposes would have been 4½c for the first 25 kwhr a month, 3c for the next 75 kwhr and 1c for all in excess. Thus, except for the first 25 kwhr, the rates would have been lower than the rates charged for domestic purposes by the Municipal Lighting Plant of Holyoke, where the rate is 4c a kwhr for the first 100 kwhr and 3½c for the excess. A customer using 25 kwhr a month would have paid, under such assumed rates, 12½c more than under the Holyoke rate, but one using 50 kwhr would have paid 12½c less, and one using 100 kwhr would have paid 62½c less. Furthermore, all customers using in excess of 100 kwhr would have paid 2½c less a kwhr for such excess.

Notwithstanding that the company's earnings are probably not much more than 4 per cent of that which a Master appointed by a Federal court would find as the fair value of the company's prop-

erty for rate making purposes, and notwithstanding that the company is furnishing service to the public at a less cost than it could probably now furnish such service itself, we would unhesitatingly adopt one of the two suggestions made by the petitioners if conditions were normal, which they are not. There has been a distinct shrinkage in the net revenue of the company during the year 1933 from that of 1932, notwithstanding it reduced its operating expenses $59,754.86. Moreover, the costs of materials, used by the company and the cost of labor employed have increased and are likely to increase further due to the National Industrial Recovery Act. The company estimates from its experience that its annual costs, as a result of this Act, will be increased by $149,000 to $175,000 a year. We believe the estimate conservative. Coal alone has increased in cost between 70c and $1 a ton. It is expected that the price of coal, at least that used for gas, will be increased still further. The amount of coal annually used by the company is approximately 100,000 tons, it having used in 1932, 103,009 tons and in 1933, 98,483 tons. The increased cost of coal alone will account for a large part of the increase in cost of operation estimated by the company. It is the policy of the Federal Government, as we understand it, to raise the price of commodities and thus it is obvious that the company will be required to pay increased prices for all materials and supplies. In addition, the shortening of the hours of labor of employees will throw added burdens upon the company. The company, on the other hand, cannot, without the approval of the Department, raise the price of anything that it sells except coke, residuals derived from its gas operations and gas and electric appliances.

The company, in its operations in the year 1933, shows net earnings available for dividends of $915,789.91. This is a decrease in net earnings from those experienced in the year 1932 of $75,627.39. The 1933 earnings fall short of the requirements of current dividends by $67,000. If the effects of the National Industrial Recovery Act had been experienced throughout the year the loss in revenue, compared with that of 1932, would have been much larger.

The company is one of the few electric or gas comapnies in New England that is free from holding company control. It is independently managed and no question of the value of management or other like contracts is involved. The petitioners concede that the company has been honestly and efficiently managed. We are not satisfied that it would be just to the company to make the reductions suggested, in view of the falling net revenues of the company resulting from the depression, and the increased costs of operation. We think it obvious that some allowance should be made to the company as a reward for intelligent management and for the risk of the capital employed in the enterprise.

Under the traditional policy of regulation which has obtained in this Commonwealth, the earnings of the utility are restricted in times of general prosperity and, by the same token, we think they ought not to be unreasonably impaired in times of adversity. The notion that prices of services furnished by a public utility should rise and fall with the prices of other commodities is unsound. A public utility is performing a public service which might properly be undertaken by the public itself. We allow to those who furnish the capital a reasonable return as compensation for furnishing this capital. It is much the same as when the public pays interest on bonds to obtain the necessary capital to establish and maintain such an enterprise itself. Obviously the payment for the use of capital, where the enterprise is privately conducted, must be larger than where the public borrows the money itself, because the public in no way guarantees the repayment of the capital and the company must also pay taxes on the capital employed. Under the system of regulation as administered in the Commonwealth there is not much more reason to expect rates to be reduced in times of depression than there is to expect like reductions in taxes. Apart from the payment of the cost of capital employed, which is represented by interest and dividends, the main expenditures of a gas or electric company which manufactures its gas or electricity are for taxes, coal, oil and labor. If these go down, its costs go down; if they increase, its costs go up. There is less reason to expect such reductions by the privately operated utility than by the publicly operated utility, as the privately operated utility must meet taxes from which the publicly operated utility is free.

Complaint was made at the hearing that the company had increased its voltage and that this resulted in the domestic customer using more electricity than he otherwise would and in shortening the lives of the lamps and appliances installed under the lower voltage. It appears that in January or February, 1932, it was determined by the company to increase its voltage from 115 to 120 volts. It was believed that the increased voltage would furnish improved service. This is the accepted view, held by the managements of many of the larger companies in the country. Before increasing the voltage, the company, in February, 1932, issued a request to lamp dealers and distributors to thereafter sell 120 volt lamps. On March 1, 1932, the company increased its voltage of 116 volts, and on the first day of each month succeeding it increased the voltage 1 volt, until it reached the voltage of 120 volts on July 1, 1932. We find nothing in this change of voltage to affect our views hereinbefore expressed in relation to the rates.

As to the petition of the Selectmen of the Town of Marblehead for a revision of the terms of the contractual relationship existing between the Lynn Company and the Marblehead Municipal Lighting Board, the Department has the right, upon its own initiative, to revise the rates, prices and charges of such a contract, under the provisions of Sec. 94 of Chap. 164 of the General Laws, Tercentenary Edition, "where a company has been serving the consumer for more than three years under a special contract or contracts." The petitioners, however, base their petition on Sec. 94A which provides that: "No gas or electric company shall hereafter enter into a contract for the purchase of gas or electricity, covering a period in excess of two years without the approval of the department unless such contract contains a provision subjecting the price to be paid thereunder for gas or electricity to review and determination by the department in any proceeding brought under section 93 or 94." The contract entered into between the company and the Lighting Board contains such a provision. There is some question, however, whether the contract is a legal contract. Assuming, however, that the contract is a legal contract, we are of the opinion that the provisions of Sec. 94A were designed primarily to give the Department power, in a proceeding instituted under the provisions of Sec. 93, by the mayor of a city or the selectmen of a town where a company is operating, or upon the petition of 20 consumers thereof, complaining of the quality or price of gas or electricity to revise the terms of any contract which the company has entered into for the purchase of gas or electricity. This, we think, is not the situation here. The company is not engaged in the business of the distribution

(Continued on page 176)

RECENT PUBLICATIONS OF THE INSTITUTE

Pub. No.		*Date Issued*	*Price to Members*	*Price to Non-Members*	*Price to Foreign Countries*
B1	Electric Service for Oil and Gasoline Pipe Line Pumping	(3/34)	$0.10	$0.25	$0.30
B2	Air Conditioning—1934	(5/34)	.75	1.85	2.00
A1	The Electric Light and Power Industry, 1932	(8/33)	.30	.75	.85
A2	Station Piping	(8/33)	.60	1.50	1.60
A3	Turbines	(8/33)	.75	1.85	2.00
A4	Burning of Liquid and Gaseous Fuels	(7/33)	.30	.75	.85
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A19	Hydraulic Governors	(8/33)	.20	.50	.60

In addition to the above publications, the following committee reports have been published in the EDISON ELECTRIC INSTITUTE BULLETIN. Single copies of the BULLETIN are priced at 25c.

Outdoor Meter Installations and Suggested Form of Housing for Outdoor Meters—*May, 1933, issue.*
Performance of Insulating Oils in Transformers—*May, 1933, issue.*
Lamp Sales in 1932—*August, 1933, issue.*
Suggested Standard Packages for Overhead Lines Material—*August, 1933, issue.*
Power System Interconnection—*September, 1933, issue.*
Hydrogen Cooled and Outdoor Air Cooled Rotating Machinery—*September, 1933, issue.*
Foreign Practice on Arcing-Ground Suppressors—*September, 1933, issue.*
Foreign Practice on Insulating Oils in Transformers and Oil Circuit Breakers—*September, 1933, issue.*
1933 Progress Report on Operating Experience with Reclosing Circuit Breakers—*December, 1933, issue.*
U.R.C. Type Weatherproof Wire for Overhead Conductors—*January, 1934, issue.*
Electric Service for Oil and Gasoline Pipe Line Pumping—*February, 1934, issue.*
Damage to Wood Poles and Cross Arms Caused by Lightning—*February, 1934, issue.*
Interchangeable Cable Entrances for Underground Transformers—*February, 1934, issue.*
Status of Meter Mounting Development—*February, 1934, issue.*
Bibliography of Commercial Cooking and Baking Articles—*February, 1934, issue.*
Rates Lowered on Machinery Insurance for Public Utilities—*March, 1934, issue.*

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420 Lexington Avenue, New York, N. Y.

The Institute has in stock a limited number of reports prepared by Engineering Committees of the former National Electric Light Association during the past several years. A price list will be forwarded upon request.

MISSOURI ASSOCIATION OF PUBLIC UTILITIES CONVENTION

Fred Karr, president of the St. Joseph (Mo.) Gas Company, was reelected President of the Missouri Association of Public Utilities at the annual State convention of the Association held April 19 and 20 at the Elms Hotel, Excelsior Springs, Mo.

Other officers elected were: First Vice-president, C. E. Michel, Union Electric Light & Power Co., St. Louis, Mo.; Second Vice-president, C. F. Farley, Kansas City Power & Light Co., Kansas City, Mo.; Third Vice-president, D. W. Snyder, Jr., Missouri Power & Light Co., Kansas City, Mo.; Treasurer, Hermann Spoehrer, Union Electric Light & Power Co., St. Louis, Mo.; Secretary, N. R. Beagle, Missouri Power & Light Co., Jefferson City, Mo.; Assistant Secretary, Jesse Blythe, Jefferson City, Mo.

Executive Committee: W. H. Swift, Jr., Springfield (Mo.) Gas and Electric Co.; T. J. Strickler, Kansas City (Mo.) Gas Co.; L. W. Helmreich, Capital City Water Co., Jefferson City, Mo.; E. H. Lewis, St. Louis County Gas Co., Webster Groves, Mo.; Fred H. Luecke, Missouri Public Service Co., Warrensburg, Mo.; A. E. Bettis, Kansas City (Mo.) Power & Light Co.; H. M. Patton, Union Electric Light & Power Co., St. Louis, Mo.; H. B. Newman, Missouri Utilities Co., Cape Girardeau, Mo.

The member companies of the Association include virtually every privately-owned electric, gas, water, and street railway utility in Missouri. About 200 delegates from throughout the State attended the meeting.

Judge H. O. Caster, New York City, president of the American Gas Association, and H. S. Tritle, East Pittsburgh, Pa., president of the National Electrical Manufacturers Association, delivered addresses at the convention.

Among the other speakers were: A. W. Conover, Bristow, Okla., member of National NRA Code Authority; Dr. Allen B. Albert, Chicago, Ill., American Federation of Utility Investors, Inc.; R. M. Conner, Cleveland, Ohio, director, American Gas Association Testing Laboratory; J. F. Porter, Kansas City, Mo., President, Kansas City Power & Light Co.; Frank R. Innes, Chicago, Ill., western editor of *Electrical World;* N. T. Veatch, Jr., Kansas City, Mo., consulting engineer; and E. A. Freund, St. Louis, Mo., load development engineer, Union Electric Light & Power Co.

An open forum for the discussion of local utility problems was held at the

MR. KARR

night session April 19. The three subjects discussed were: "A Study of Rates of Municipal and Privately-Owned Utility Plants in Missouri," "Today's House Heating Market," and "Diversion of Utility Services." The leaders of the discussion were: O. F. Funk, St. Louis, Mo., Union Electric Light & Power Co.; F. M. Rosenkrans, Kansas City, Mo., Gas Service Co.; and Dudley Sanford, Webster Groves, Mo., St. Louis County Gas Co.

An Employees' Speaking Contest, sponsored by the Association, was held on the evening of April 18, in connection with the convention. Men and women employees of all privately-owned utilities in Missouri were eligible. The contestants were selected by company eliminations.

The winners in the State contest were: Women—First, Miss Rosa Burchett, Kansas City (Mo.) Power & Light Co.; second, Miss Thelma L. Feeney, Union Electric Light & Power Co., St. Louis, Mo. Men—First, Robert W. Cleveland, Union Electric Light & Power Co., St. Louis, Mo.; second, Herbert Henderson, Missouri Power & Light Co., Jefferson City, Mo.

Loving cups were given to the first and second prize winners in each class.

The annual banquet and carnival was held on the evening of April 20. President Fred Karr acted as toastmaster. A special entertainment program was provided for the ladies attending the convention.

The place of holding the convention next year will be selected by the Executive Committee at a later meeting.

NORTHWEST ELECTRIC LIGHT & POWER ASSOCIATION ACTIVITIES

Engineers and accountants of the Northwest Electric Light & Power Association will convene in two separate meetings between now and the end of the current Association year, June 30. The Engineering and Operation Section will meet in Portland, Ore., May 17-19, 1934, with headquarters at the Old Heathman Hotel, with William S. Hill, Grays Harbor Railway & Light Company, Aberdeen, Wash., Section Chairman, presiding.

The scope of the section under the reorganization effected by the Association last year has been broadened to include operating problems as well as those of design and construction and much of the program this year will be given over to a discussion of these operating problems. The section is divided into four main committees: (1) Production and Generation; (2) Transmission and Distribution, (3) Utilization, (4) General.

In the Production and Generation group a subject of timely interest will be the design of the turbines for the Bonneville development by L. F. Harza, consulting engineer, Chicago, who has been retained by the Army Engineers to assist in this design. The balance of the program of this committee will be taken up in short discussions of operating problems in hydro-electric and steam generation. A symposium on power factor correction in three papers will constitute the major part of the program of the Transmission and Distribution Committee. A new committee this year is on Utilization, on the program of which are four papers on "Illumination," "Wiring," "Energy Theft," and "Utilization Devices." The General Committee will bring up to date and report the accident experience of member companies.

The Accounting and Business Practice Section will hold its 1934 Annual meeting in Seattle, June 25-26, at the

(Continued on page 176)

INDUSTRIAL HEATING NEWS

Contributed by Industrial Power & Heating Committee, E.E.I.

WESIX ELECTRIC WINE PASTEURIZER

This pasteurizer is a portable device consisting of two vertical copper cylinders, one of which is a heater and the other a cooler. They both contain a number of straight vertical copper tubes similar to a tubular boiler. The heating chamber is equipped with three 7½ kw electric heaters with thermostatic control. These heaters raise the temperature of water around the tubes in the heating chamber and the wine is passed through these tubes, entering at 53° F. and leaving at 156° F. The cooling chamber is used to preheat the incoming wine by circulating the wine leaving the heater around the tubes in the cooling chamber. —*Submitted by Pacific Gas & Electric Co., San Francisco.*

MANUFACTURERS' CATALOGS

The General Electric Company has just issued its new catalog, G.E. A-1520B, on electric heating units and devices. This catalog contains considerably more information on equipment and applications than the old one.

The Edwin L. Wiegand Company has just issued its new catalog, No. 34, containing prices and information on an unusually large amount of equipment of the small unit type.

Both of these catalogs should be a very useful aid in promoting the use of this kind of equipment.

DECORATED PAPER BAGS

A St. Louis paper converter and manufacturer of decorated paper bags formerly used an oil fired steam boiler and gas for its process heating which included glue cooking, drying dyed paper, heating embossing rolls, and heating a rubber vulcanizing press for making rubber mats for printing.

After an investigation and recommendation by the Power Company's engineers, the customer installed two 6 kw water circulating units on existing glue cookers, four 6 kw special hot plates for drying the paper on converter machines, two 3 kw specially constructed steam generators for supplying steam for heating embossing rolls, and built a 9 kw vulcanizing press using steel-clad strip heaters—a total load of 51 kw.

The installation of this electric heating load, which is equal to the previous total plant power demand, resulted in bringing this plant's total electrical requirements up to the point where a primary rather than a secondary power rate was applicable. Actual operation has borne out the fact that, due to the flexibility and efficient application of electric heat, the operating costs are actually lower than the former costs of oil fired steam boiler operation.—*Submitted by Union Electric Light and Power Co., St. Louis.*

BEER CUPS MADE WITH ELECTRIC OVEN

Beer cups turned from Redwood are given two coats of varnish. After each coat they are baked in an electric oven provided with a circulating fan. The connected load of this oven is about 22 kw and, in addition to baking the special varnishes on Redwood hollow-ware, is used for a preliminary drying on other wood products.

This oven was purchased last fall principally for the purpose of producing beer cups and the quantity of work and control possible has resulted in a very satisfied customer.—*Submitted by Philadelphia Electric Company, Philadelphia.*

ELECTRICALLY HEATED BOILERLESS PRESSING MACHINE

The U. S. Hoffman Machinery Corporation is announcing to the trade a new development in pressing machines. This machine has a total load of 6.2 kw and the average current consumption of the machine under operation is 4 kwhr per hour. The capacity of the machine is 40 to 60 suits per day. Spray steam is available as a result of spraying water against hot plates. The water is supplied from a constant pressure tank. Initial heating takes 15 minutes. Operating costs with electric rates of 4c or under will compare favorably with the cost of operating miniature gas fired boilers, according to the United States Hoffman Machinery Corporation. The heating elements and controls are supplied by the G.E. Company.

In all field tests, according to this company, there is no tendency to "shine" fabrics with this electrically heated machine.—*Submitted by Union Electric Light and Power Co., St. Louis.*

Winners in Better Copy Contest Announced

Awards in the 1934 Better Copy Contest, conducted by the Public Utilities Advertising Association have been announced. L. D. Gibbs of the Edison Electric Illuminating Company of Boston is chairman of the Better Copy Committee of P.U.A.A.

The awards will be presented at the P.U.A.A. departmental meetings in connection with the Advertising Federation Convention at the Hotel Pennsylvania, New York City, which opens Sunday evening, June 17, 1934.

Thirty-one awards were made by the Judges in the eight classifications for advertising material, including first and second places and two honorable mentions in each class but one.

Between 6500 and 7000 proofs of advertisements were considered by the Judges of the Better Copy Contest.

The winners in the electric light and power sections were:

Outdoor Billboard

First prize—San Antonio Public Service Company; second prize—New York Edison Company; honorable mention—Dallas Power & Light Company; honorable mention—Consolidated Gas Company of N. Y.

Electric Window Display

First prize—New York Edison Company; second prize—Tennessee Electric Company; honorable mention—Florida Power & Light Company; honorable mention—New York Edison Company.

Electric Newspaper Advertisement

First prize—Dallas Power & Light Company; second prize—Central Hudson Gas & Electric Corp.; honorable mention—Consumers Power Co., Michigan; honorable mention—Philadelphia Electric Company.

Campaign Advertising

First prize—Northern States Power Co., Minneapolis, Minn.; second prize—Peoples Gas Light & Coke Co., Chicago, Ill.; honorable mention—Consumers Power Company, Michigan; honorable mention—Union Electric Light & Power Co., St. Louis, Mo.

General Utility Advertisements

First prize—Northern States Power Co., Minneapolis, Minn.; second prize—Central Hudson Gas & Electric Corp.; honorable mention—Central Hudson Gas & Electric Corp.; honorable mention—Union Gas & Electric Co., Cincinnati.

POWER SALES ITEMS

AIR CONDITIONING

"90 in the Shade, But Only 75 in the Sun Tube Company's Air-Conditioned Plant. Operators Like to Work, Won't Stay Home." Factory Management and Maintenance, April, 1934, pp. 158-9. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

The application of air conditioning in this plant has bettered employee conditions and has improved the product to such an extent that rejections are not nearly as numerous.

"Cold—From Steam!" by E. F. Stalcup. Factory Management and Maintenance, April, 1934, pp. 184-6. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

Old in principle, but new in its commercial application, steam jet refrigeration may be the right answer to air conditioning and process cooling needs.

"Plan Now for Desirable Air-Conditioning Load," by R. E. Hellmund. Electrical World, March 17, 1934, pp. 404-407. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

The author of this article points out the need of planning for future air conditioning loads. It will be necessary to look ahead and provide distribution facilities for the safe and economical service for air conditioning loads. As cost of air conditioning equipment is reduced the public will buy equipment following somewhat the same cycle as domestic and commercial refrigerators did a few years ago. The author points out the possibility of the reverse cycle for both cooling and heating which will give the desirable load factor for summer and winter loads. It is pointed out that the steam jet system of air conditioning will be a formidable competitor of electricity.

DIESEL ENGINES

"Diesel Diagnosis with Pyrometer and Indicator," by William Sheffer. Power Plant Engineering, April, 1934, pp. 194-5. Technical Publishing Company, Manadnock Block, 53 West Jackson Blvd., Chicago, Ill.

The article shows that a pyrometer is a necessary accessory to a Diesel engine, and when it is used intelligently in conjunction with an indicator the engineer will be able to diagnose ills to which an engine may be subject.

ELECTRIC MOTORS

"Industrial Electric Motors," by H. W. Reding. Electrical South, April, 1934, pp. 31-34. W. R. C. Smith Publishing Company, Grant Building, Atlanta, Georgia.

It is obvious that the reason for the extreme popularity of induction motors is the unusual combination of simplicity, good operating characteristics and economical cost. The wide variety of electrical and mechanical characteristics which may be obtained for special purposes naturally tends to increase the desirability of the motor. A good machine with the right motor is the mainstay of present-day industry.

"Watt-Hours Cheaper Than Burrs as Cotton Gin Power," by T. V. Grayson. Electrical World, March 17, 1934, pp. 400-403. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

This article deals with the possibilities of additional load by motorizing cotton gins. The author points out the feasibility of electric power and comparative cost of operation of various types of prime movers. Electrical power competes with steam power even when the fuel is waste burrs and therefore free. It is pointed out that there are a large number of second-hand motors in good condition that can be utilized by the cotton gin operators which make the changeover comparatively inexpensive. It is pointed out that energy consumption can be reduced by reducing the speed of the blast fans several hundred r.p.m. without impairing the efficiency of the gin.

INDUSTRIAL ELECTRIFICATION

"Your Power. When to Buy It—When to Make It," by David Moffat Myers. Factory Management and Maintenance, April, 1934, pp. 155-158. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York City.

A harvest of economies awaits the complete adoption by industry of that simple policy of buying power where it should be bought and making it where it should be made.

OBSOLESCENCE

"Obsolescence Insurance," by J. C. Knapp. Mill and Factory, April, 1934, pp. 39 and 94-5. Conover-Mast Corporation, 205 East 42nd Street, New York City, Publishers.

Obsolescence is now being carried on separate accounts, but the article speaks of obsolescence insurance as a thing of the future. The author shows the difference between obsolescence and amortization and the need for each.

POWER FACTOR

"Select Capacitors to Meet Power-Factor Clauses," by A. A. Bolsterli. Electrical World, March 10, 1934, pp. 375-6. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

The author of this article points out the desirability of power factor correction and sets forth the chart to base the amount of investment that can be justified when the demand charges and power factor correction charges are known. With the use of a chart the annual capacitor charges can be balanced against the marginal Kva. rate savings. This method produces the most economical solution for the handling of power factor problems in industrial plants.

"Utility-Provided Unit Corrects Power Factor," by E. C. Stoever and A. N. Lendman. Electrical World, April 14, 1934, p. 556. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

The authors of this article have pointed out the method used by one utility to correct poor power factor in an industrial plant. The method outlined provides that the utility furnish the equipment and the industrial plant pays by installments, which represents the saving due to the improved power factor.

"Power-Factor Correction on a Benefit-to-all Basis," by L. H. Knapp. Electrical World, March 31, 1934, pp 466-468. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

This article deals with the practice followed by the Blackstone Valley Gas & Electric Company in dealing with power factor correction for their industrial customers. It is pointed out that the industrial user, the utility and the electrical manufacturer will all gain by a power factor correction plan such as is used by the above mentioned company. Attention is called to the fact that the NRA working conditions in some cases have caused increased industrial peaks due to shorter hours. Power factor correction makes it possible in some of these cases to carry the increased peak load without excessive rebuilding of wiring facilities. The article sets out the policy employed in assisting the industrial customers to obtain better power factor correction.

STEAM PLANTS

"Pulverized Coal, New Boilers and Turbines Pay Out in Five Years," by J. M. Lenone. Power, April, 1934, pp. 184-6. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

Pulverized coal, integral economizers and tubular air heaters replace antiquated boilers and natural-draft chaingrate stokers. Steam pressure stepped up so that 2-point bleeding and 10-lb. exhaust can be used for heating and process. Bleeder turbines provide power formerly purchased.

"New Turbines with Old Boilers May Pay Quickest in Packing Plant," by J. Y. Dahlstrand. Power, April, 1934, pp. 188-9. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

Often, a small investment in power equipment pays a big return. Turbine-generators installed in old boiler plants are here shown to be a decidedly economical move.

"Power for French Refinery." Power, April, 1934, pp. 200-1. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

By-product power is generated from process steam for refinery purposes and for power-plant auxiliaries in the new plant of Raffineries de la Vacuum Oil Co., S. A. F., at Port Jerome, France.

SYNCHRONOUS MOTORS

"Power Savings Save Old Grain Elevators —A Sample of Sensible Modernization," by M. A. Buettell. Power, April, 1934, pp. 176-7. McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City.

Grain elevators require but little heating steam, therefore are not adapted to economical steam-power generation. Conversion to synchronous-motor drives makes power cost less than fuel.

"Quick Stopping Motor for Rubber Mill." Power Plant Engineering, April, 1934, p. 171. Technical Publishing Company, Monadnock Block, 53 West Jackson Blvd., Chicago, Ill.

The article concerns a quick-stopping 1,000 H. P. Westinghouse synchronous motor which has been developed for use at the Goodyear Tire and Rubber Company at Akron, Ohio. The rotating element of this motor weighs more than three tons and rotates at a speed of 514 r.p.m. In case of emergency, this motor can be stopped in one and one-quarter seconds which is equivalent to three and one-half revolutions.

Northwest Electric Light & Power Association Activities

(Continued from page 173)

call of O. W. Bennett, Puget Sound Power & Light Company, Section Chairman.

Subjects to receive consideration at the meeting are: "The Accountant's Place in Regulatory and Rate Hearings," "The Application of Certain Accounts Under the Standard Classification," "The Effect of Taxes," "Practices on Collections and Credits under the Unusual Conditions Now Prevailing," "Summary of Billing Systems in Use in the Association Territory," and the "Accountant's Part in the Handling of Theft of Current and its Prevention." Other subjects of wide general interest to accounting department personnel may be introduced.

Decision of Massachusetts Commission in Dismissing Petition

(Continued from page 171)

and sale of electricity in Marblehead. Consequently, no petition can be brought by the selectmen for the revision of the rates of the Lynn Company. Any proceedings to revise the terms of the contract, consequently, in our opinion, must be under the provisions of Sec. 94, upon the initiative of the Department.

It appears that the Municipal Lighting Board was convinced that the price proposed by the Lynn Company for electricity was less than it would cost the town itself to generate electricity. It arranged with the Lynn Company that it should supply the Municipal Lighting Plant with such amounts of electricity as it might require at any time, and reserved to itself the right to operate the Municipal Lighting Plant for at least 10 hours in each day. As a consequence, the Lynn Company expended $13,131 in transmission lines and other construction to transmit electricity from the Swampscott substation to the Swampscott-Marblehead line. The company contends that since this expenditure it has made expenditures to strengthen its lines between its generating plant and the Swampscott substation and it estimates it has capital investment devoted to the Marblehead service of about $77,000. In view of the circumstances under which the contract was entered into, and the conditions under which the electricity is sold, we see nothing unreasonable in the terms charged by the Lynn Company, and as a consequence, assuming we have the power under Sec. 94 to revise the terms of the contract, no reason is presented for its exercise.

Accordingly, it is

ORDERED, That the petitions be and hereby are dismissed.

By order of the Department,
(Signed) ALLAN BROOKS,
Administrative Secretary.

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CONVENTIONS AND MEETINGS

MAY

1-4 Chamber of Commerce of the United States of America, Washington, D. C.
14-18 National Fire Protection Association, Haddon Hall, Atlantic City, N. J.
16-18 American Institute of Electrical Engineers, Worcester, Mass.
20-24 National Electrical Manufacturers Association, The Homestead, Hot Springs, Va.
24 National Board of Fire Underwriters, Waldorf-Astoria Hotel, New York, N. Y.

JUNE

4-7 Annual Convention, EDISON ELECTRIC INSTITUTE, Traymore Hotel, Atlantic City, N. J.
12-14 Telephone and Telegraph Section of the American Railway Association, Hotel Stevens, Chicago, Ill.
13-15 Canadian Electrical Association, The Log Chateau, Seigniory Club, Lucerne-in-Quebec, Canada.
18-21 National Association of Purchasing Agents, Hotel Cleveland, Cleveland, Ohio.
25-28 Fifteenth International Cost Conference, National Association of Cost Accountants, Hotel Cleveland, Cleveland, Ohio.
25-29 American Institute of Electrical Engineers, The Homestead, Hot Springs, Va.

SEPTEMBER

24-28 American Transit Association, Cleveland Public Auditorium, Cleveland, Ohio.

AIR CONDITIONING—1934

E. E. I. Publication No. 32

Comprehensive and practical information designed to aid utility companies in the promotion of Air Conditioning. Price 75c. to members; $1.85 to non-members; $2.00 foreign.

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